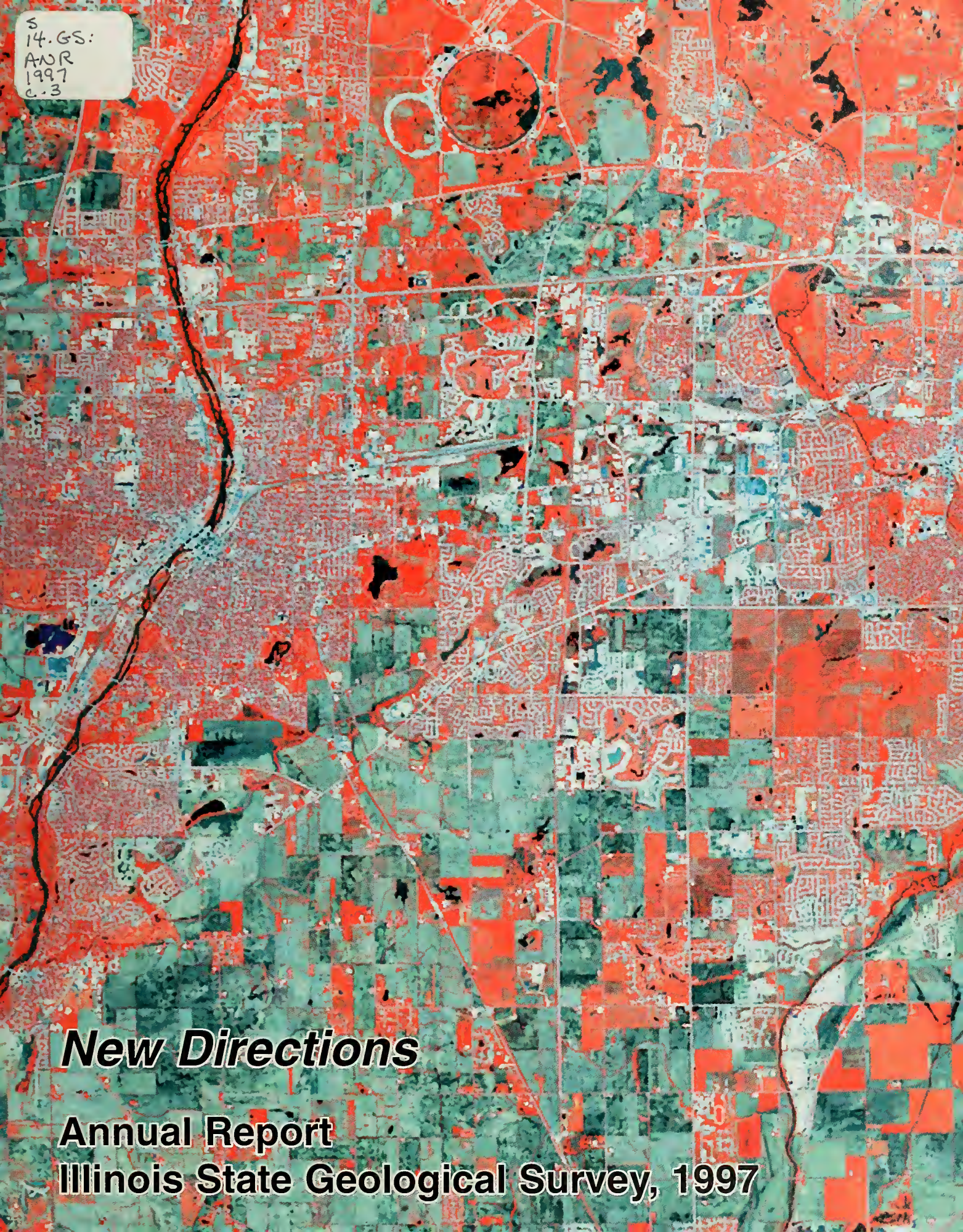
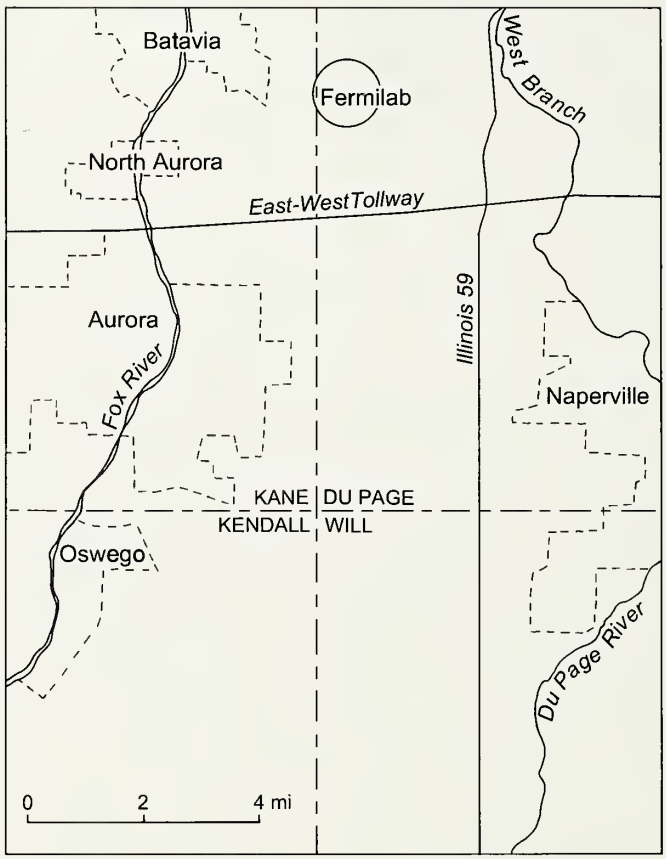


New Directions

Annual Report
Illinois State Geological Survey, 1997



The intersection of Du Page, Kane, Kendall, and Will Counties (front cover) is the interface of urban and rural culture. To the east lies the Chicago metro area; to the west (back cover) lie the farm lands of De Kalb County.

The circular landmark (center, north) is the Fermi National Accelerator Laboratory, a center for research on high-energy physics.

The cover shows a Landsat Thematic Mapper (TM) satellite image acquired on May 30, 1995. It is one of two Landsat TM images of this region used to prepare the *Land Cover of Illinois*, an inventory produced by the Illinois Department of Natural Resources.

Red shades indicate healthy vegetation found in open spaces such as lawns, parks, forest preserves, golf courses, and rural grasslands.

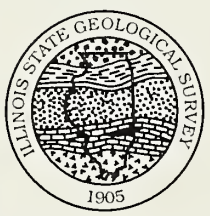
In urban areas, the white, green, and blue-green shades indicate paved-over areas such as roadways, rooftops, and parking lots. But in rural areas, white, green, and blue-green represent bare soil. The darker shaded soils have a higher moisture content.

The Illinois State Geological Survey, 1997

New Directions

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964
(217) 333-4747

Writers Ellen Wolf
Tom McGeary
Stuart Tarr
Designers Sandra Stecyk
Pamella Carrillo



Printed by authority of the State of Illinois/1,200/1997/$1.37

Printed with soybean ink on recycled paper

To the people of Illinois

The past year has been a time of significant change in our scientific direction and style of doing business at the Illinois State Geological Survey. Several changes and events have had a profound impact on how we conduct our business.

The "main event" of the past year—one that will impact us for years to come—was the implementation of our program to map the state's geology in three-dimensions and at a scale of 1:24,000. As all of us working on this program and participating in the efforts to market and explain it realize, this is not an easy task. We will have to develop many new approaches to financing the program, doing the actual mapping, and creating the map products. We are still in the "ramping up" phase of our multidimensional mapping program, and it may be several years before the most cost-efficient and -effective techniques of gathering, producing, and releasing map data are fully developed.

Another major event was publication of the geologic data to model the subsurface geology and groundwater flow of a large part of McLean and Tazewell Counties. The product of this joint effort by the State Geological and Water Surveys provides a basis for planning to meet the future water needs of Bloomington–Normal.

The geologic part of the project, similar in concept to our 3-D mapping, was not immediately successful. We experienced difficulties due to the complex geology below land surface and the variable quality of publicly supplied well records in our database. To fulfill our commitment, we subjected the mapping procedures and database interpretations at both Surveys to an intense review, and enlisted our experts in the computer-based Geographic Information System to help resolve the conceptual problems with the 3-D geologic model.

A cutting-edge, 21st-century product for McLean and Tazewell Counties—one that can be a model for groundwater planning for glaciated North America—is the result of this effort by both Surveys. As an added benefit, the exercise has drawn the Geological and Water Surveys closer together.

To get the word out about 3-D geologic mapping, the Indiana, Ohio, and U.S. Geological Surveys joined us in organizing a public forum in Indianapolis last spring. Users of geologic maps talked with us and each other about their needs for geologic maps for land-use planning, environmental protection, and geo-hazard mitigation. The USGS has since complimented the State Scientific Surveys for their leadership in involving the public in the process of producing and distributing vital geologic information.

Where will we be going during the next year? Our research and service programs will be headed in directions that I expect to be challenging, interesting, and valuable to the citizens of Illinois. We will continue to interact and cooperate with the other Scientific Surveys in Illinois and neighboring states. The days of the "lone wolf" scientist or survey are past. During the next year, we will...

- develop a "Great Lakes Mapping Initiative," in cooperation with the Indiana, Ohio, Michigan, and U.S. Geological Survey, to serve as a model for regional partnerships between the State Surveys and the U.S. Geological Survey.
- work with our colleagues in the Illinois Basin Consortium (Indiana and Kentucky) to examine how deregulation of the power industry will impact Illinois Basin coal.
- plan for and respond to federal environmental legislation, particularly with regard to protection of water supplies.
- contribute to major projects and decisions affecting lands owned and managed by the Illinois Department of Natural Resources (DNR).
- participate as major players in the earthquake research carried out by the Central U.S. Earthquake Consortium.
- strive for effective communication with our scientific colleagues and the people we serve in Illinois.

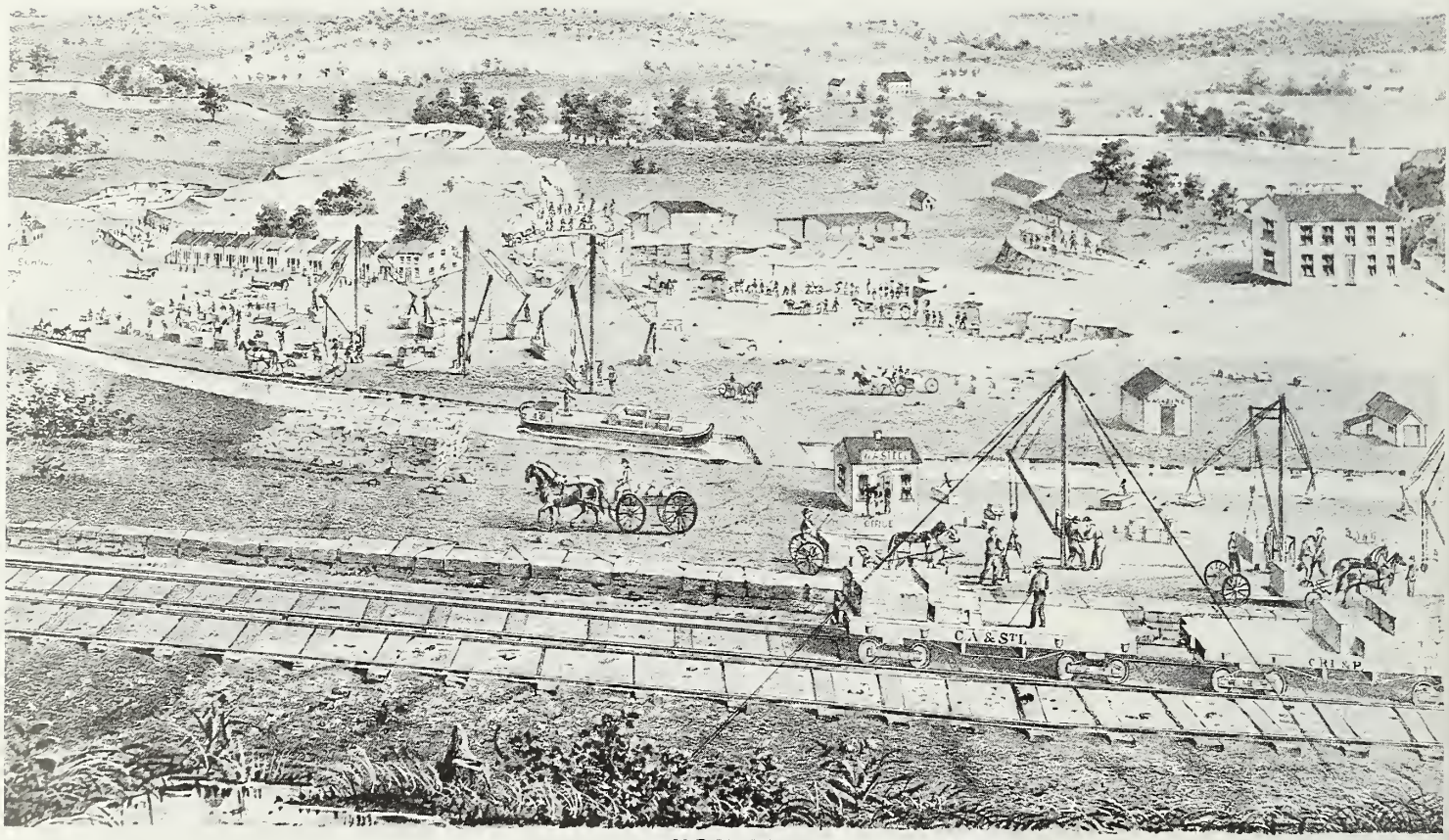
In my vision of the Geological Survey's future, our research and service is so well conceived and effectively disseminated that our advice and assistance will be sought whenever and wherever the economic and environmental well-being of Illinois involves geology. Our critical expertise will contribute to decisions of our Department of Natural Resources (DNR) and other state and local agencies because everyone will understand what we do and what geology is all about.

I see us working on teams—multidisciplinary teams from all fields of endeavor at the Geological Survey, the other Scientific Surveys, other DNR divisions, and the University of Illinois. We will pool our efforts, expertise, and resources to work, for example, on ecosystem mapping or environmental assessment of contaminated sites. We will also create mutually beneficial alliances with other Illinois State agencies, other states' geological surveys, and agencies of the federal government.

We are a strong, dynamic Survey—respected by our peers and recognized for leadership nationally and internationally. To remain so is our challenge and our commitment to the people of Illinois.

Bill Shilts

William W. Shilts, Chief



JOLIET QUARRIES. HON. W. A. STEEL, PROP.
Joliet Will County, Ills

"...Our railroads cut their way through it; our carriages drive over it; our cities are built upon it..."[1] Joliet Quarries, Will County, 1870 *In the foreground of this lithograph is the Chicago, Alton, and St. Louis Railroad. Just beyond lies the Illinois–Michigan Canal, which provided transport for stone from the full-scale quarry operation. In the distance is the Des Plaines River. Today, there's a new canal, the river's been rechanneled, and many of the old quarries lie buried under slag. In the 1950s, some of the slag was excavated and recycled as building material.*

Old quarries are prime sites, revealing the geologic history and architecture of whole regions. Near Lockport in Will County, for example, several companies operated quarries along the Illinois–Michigan Canal. The limestone quarried there went into building the State's Capitol in Springfield.

For decades, the old Joliet Quarry site was used as a slag dump for steel mills. Now the area is park land, a place to see natural geologic and biologic features side-by-side with an unnatural formation of igneous "rock." The slag looks like lava, solidified as if it had been the molten flow from a volcano. Once buried under molten metal waste, the site is now coming back to life. In Illinois, with no outcrops of volcanic rocks, here's a place to witness biologic succession on raw igneous material.

The State's geologists are searching Chicago for sites such as this, where native plant and animal communities are linked with unique geologic settings. Field adventures along the Illinois–Michigan Canal National Heritage Corridor and other sites will be offered by the GeoSurvey and the Department of Natural Resources.

[1]Donnelly, Ignatius, 1883, *Ragnarok: The Age of Fire and Gravel.* D. Appleton and Company, New York, p. 2.

New Directions

From Exploration...

Industrial society's appetite for raw materials and energy in the late 1800s rapidly outstripped the ability of untrained prospectors to locate and unearth the resources. The Geological Surveys, first established around the mid-19th century, employed a new breed of scientists—mainly charged with inventorying the earth resources of the western world.

In the United States and Canada, this geologic mapping was often carried out in lands as yet unsettled and largely unknown by Europeans. So there was an element of adventure in the early western and arctic surveys, which made geologists such as John Wesley Powell in the U.S. and James Burr Tyrell in Canada into national heroes.

The romance of geologic exploration won people's hearts and their support for setting aside great tracts of prime geology to safeguard their national treasure. In truth, preservation was often justified on the basis of saving natural resources for future *use*.

All industrial nations soon developed their own Geological Surveys. In North America, the states and provinces set up agencies to study and map the geology and mineral resources of their regions. As leaders in the search for minerals and fuels to feed society's growing industrial base, these Geological Surveys became advocates for earth extraction industries. In the public eye, geologic exploration began to be linked with mineral exploitation.

No one doubted the necessity for wise and efficient extraction of the nation's mineral wealth. No one denied the need for the Illinois and other Geological Surveys to represent the public interest in minerals exploration and research —a need that remains strong today. But many realized that mineral wealth had to be balanced with environmental health.

...To Earth Watch

The business boom of the 20th century and particularly of post-World War II consumed resources, natural and societal, as if there were an endless supply. Even so, people began to worry about how environments were changing, with air not fit to breathe, water not fit to drink, and at every city's limits, resource-rich lands disappearing under houses and highways.

The environment began to rival the economy as a matter of public concern, while the Geological Surveys began to evolve from natural resource providers to natural resource protectors.

A new "environmental" geology, pioneered by the Illinois State Geological Survey in the 1960s, first appeared in the heart of North America, and not by accident. It was as natural as the landscape, as inevitable as the fertility of soils formed in the thick deposits of sand, gravel, silt, and clay spread over bedrock by the immense ice sheets of the "Ice Age."

The geologic events of 2 million to 12,000 years ago were as significant for the northern Midcontinent as volcanic eruptions and earthquakes have been elsewhere. Glaciation gave this region the right geologic materials for a rich base of soil and water—the resources that nurture life and sustain society.

In short, glacial geology is the foundation of northern Midcontinent societies, from agrarian to industrial–technological.

But when the science of geology was new 100 years ago, no one in Mid-America, where so many people made a living from the land, would have needed a geologist to point that out. As Minnesota author and politician Ignatius Donnelley wrote in 1883, the glacial material at land surface

> ...is our earth. It makes the basis of our soils; our railroads cut their way through it; our carriages drive over it; our cities are built upon it; our crops are derived from it; the water we drink percolates through it; on it we live, love, marry, raise children, think, dream, and die; and in the bosom of it we will be buried.[1]

Today, we know how vulnerable, as well as vital, earth resources are to our complex, diverse, global society. But we do not always understand how we spoil our land, contaminate our air and water, waste our remaining mineral and fuel resources, destroy habitats for wildlife, reconstruct watersheds with no thought of natural drainage, and in so many ways, interfere with the natural processes of the earth's systems.

Only when geology, the science of earth, is fully integrated into the fabric and planning of modern societies will we be able to avoid or mitigate the effects of environmental crises brought on by the use or abuse of our fragile but fertile Midwestern landscape.

Chicago suburb

Urban Geology

In cities, the soils and other materials down to bedrock have been altered from their natural condition by excavation and construction of all sorts—for buildings, bridges, and highways; landfills; subways and tunnels; and networks of pipes, sewers, and utilities. Concrete takes the place of earth.

The State's geologists must understand the geology underlying cities, and they must understand it in the context of historic changes people have wrought in that earth. Construction and maintenance of a city's infrastructure, as well as extraction of water and other minerals, make significant alterations in the original, "natural" geology. Urban geologists must also be aware of the substances—solids, liquids, gases—that people introduce into the earth. How do they migrate, and where do they go? One land-use problem that geologists frequently encounter in urban settings, for example, is contamination from old gasoline storage tanks, industrial chemical spills, and even wastes from turn-of-the-century coal gas plants.

Economic and environmental issues are at the core of the Illinois GeoSurvey's urban geology program:

- More than three-fourths of the 100 environmental assessments that the GeoSurvey makes each year for the Illinois Department of Transportation are at urban sites. *[See next page and p. 15.]* The mission of these projects is public safety.

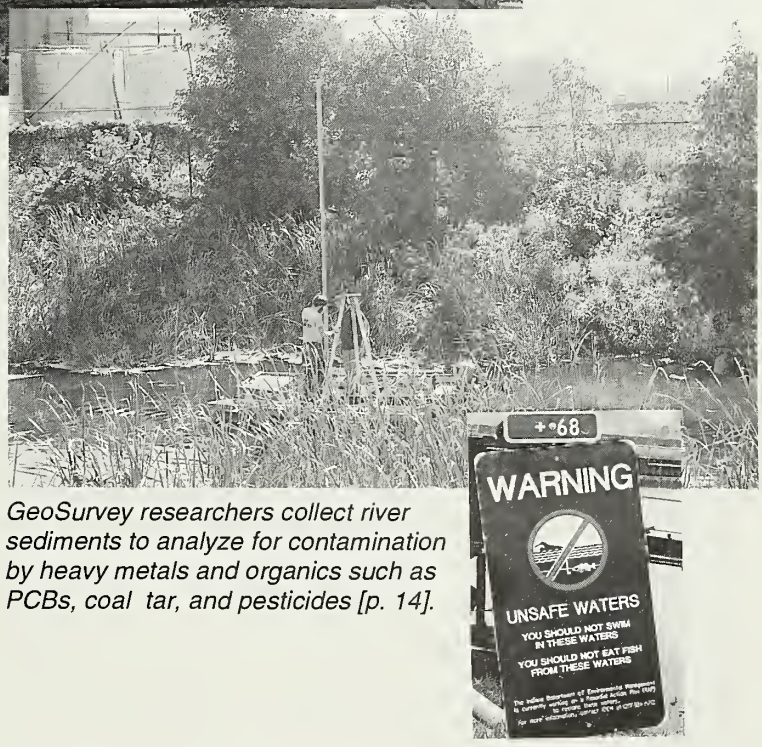
Cities crowd up to the edge of a quarry, then people in the neighborhood grow unhappy with the noise and dust of the quarrying operation. What they forget is that they can't do without this geologic resource. Houses and high rises, shopping malls, streets and sidewalks, bridges, levees, lakefronts, and expressways—in short, the city's entire infrastructure is built with crushed stone.

When local sources of stone disappear, hauling it from a distant pit to where it's needed can greatly boost the cost. That's why some modern quarry operations are going underground.

First and last *The Stearns Quarry in the Bridgeport neighborhood of south Chicago, about 3 miles south of the Loop, began operations in the 1830s. The quarry, the first to open in Chicago, was an important source for crushed stone and lime. Its stone was used to build the first breakwaters for the Chicago Harbor (now the Navy Pier area). Also, thousands of fossils collected here in the 19th century are now in museums all over the world.*

The Bridgeport neighborhood quarry was also the last to operate in the city of Chicago. When it closed in 1969, it was 380 feet deep. Now the city uses it as a clean landfill for concrete, street sweepings, and incinerator ash. Already two-thirds filled-in, the Bridgeport quarry will soon be park land.

Pollution has been a big problem since early in the century, when industry and shipping staked claims to the territory of rivers and canals south of Lake Michigan. Contamination of the west branch of the Calumet River started in the 1930s and peaked in the 1960s, according to studies by the Illinois GeoSurvey and the Sanitation District of Hammond, Indiana.



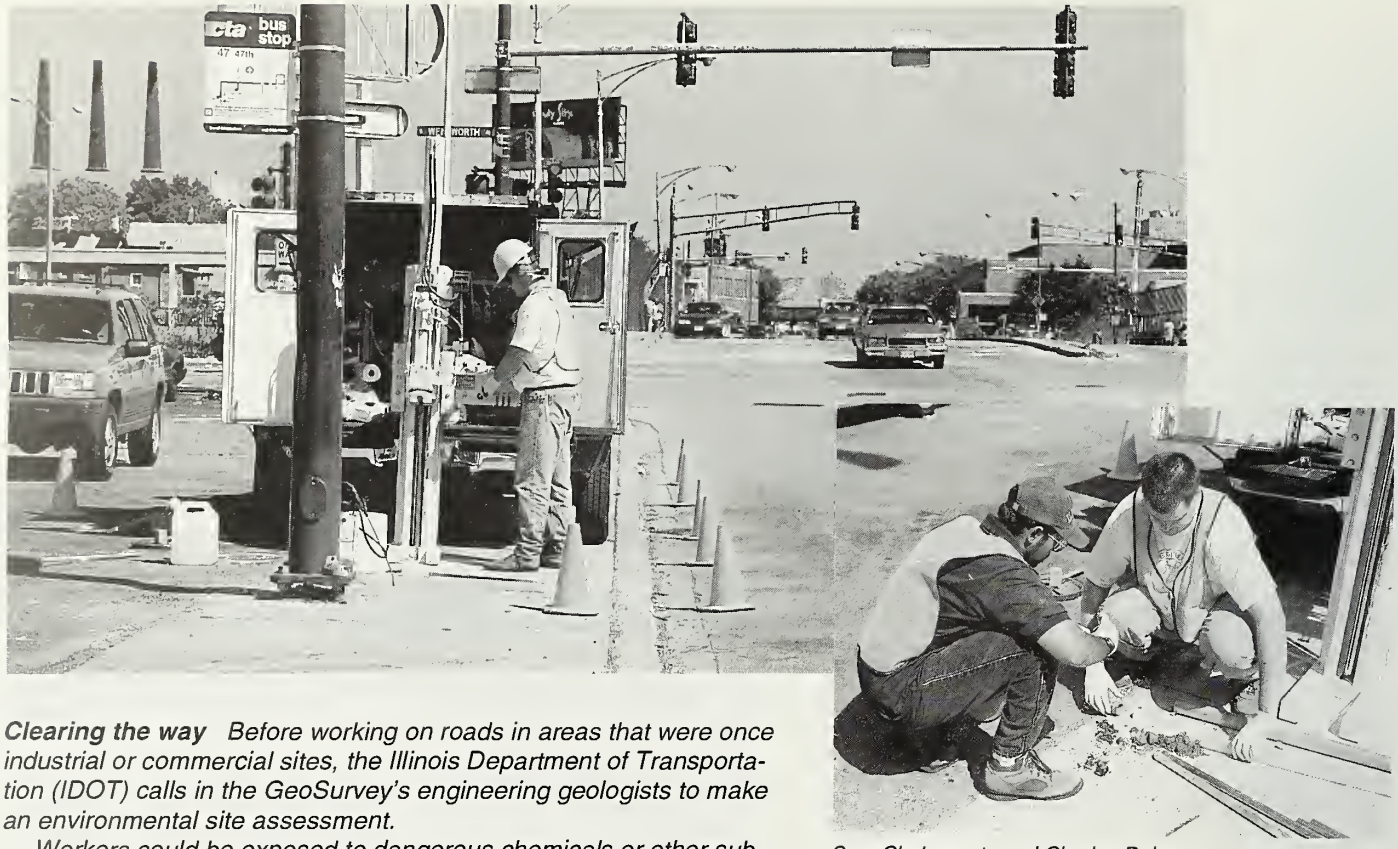
GeoSurvey researchers collect river sediments to analyze for contamination by heavy metals and organics such as PCBs, coal tar, and pesticides [p. 14].

The "hazardous air pollutants" (HAPs) released into urban skies by burning Illinois coal can be cut, on average, by more than 20% with conventional coal-cleaning methods *[p. 10]*. These findings from a recent GeoSurvey study were submitted to the U.S. Environmental Protection Agency, which is assessing the health risks of HAPs from all U.S. coals.

No longer available for mining are 60–70% of coal resources at the western edge of the Illinois coalfield, across the river from St. Louis *[p. 10]*. The reason, according to a recent assessment by GeoSurvey coal geologists, is expansion of the St. Louis metro region. Homeowners and developers in this region (and counties throughout Illinois) also use the GeoSurvey's coal mine maps and directories to avoid undermined areas.

"Activated" carbons, developed from Illinois coals by the GeoSurvey's minerals engineers, match or top the performance of commercial carbons at removing sulfur dioxide, nitrogen oxide, mercury, and other impurities from flue gases of coal-fired plants *[p. 11]*.

From 1995–1996, the net loss of nearshore sand along Lake Michigan in the vicinity of Illinois Beach State Park was five times the average annual net loss between 1992 and 1995 *[p. 8]*. Results from year 2 of a 4-year mapping project by the State's coastal geologists were used to calculate the sand needed for beach "nourishment," which helped prevent an even higher annual net loss.



Sam Chakravorty and Charles Dolan

Clearing the way *Before working on roads in areas that were once industrial or commercial sites, the Illinois Department of Transportation (IDOT) calls in the GeoSurvey's engineering geologists to make an environmental site assessment.*

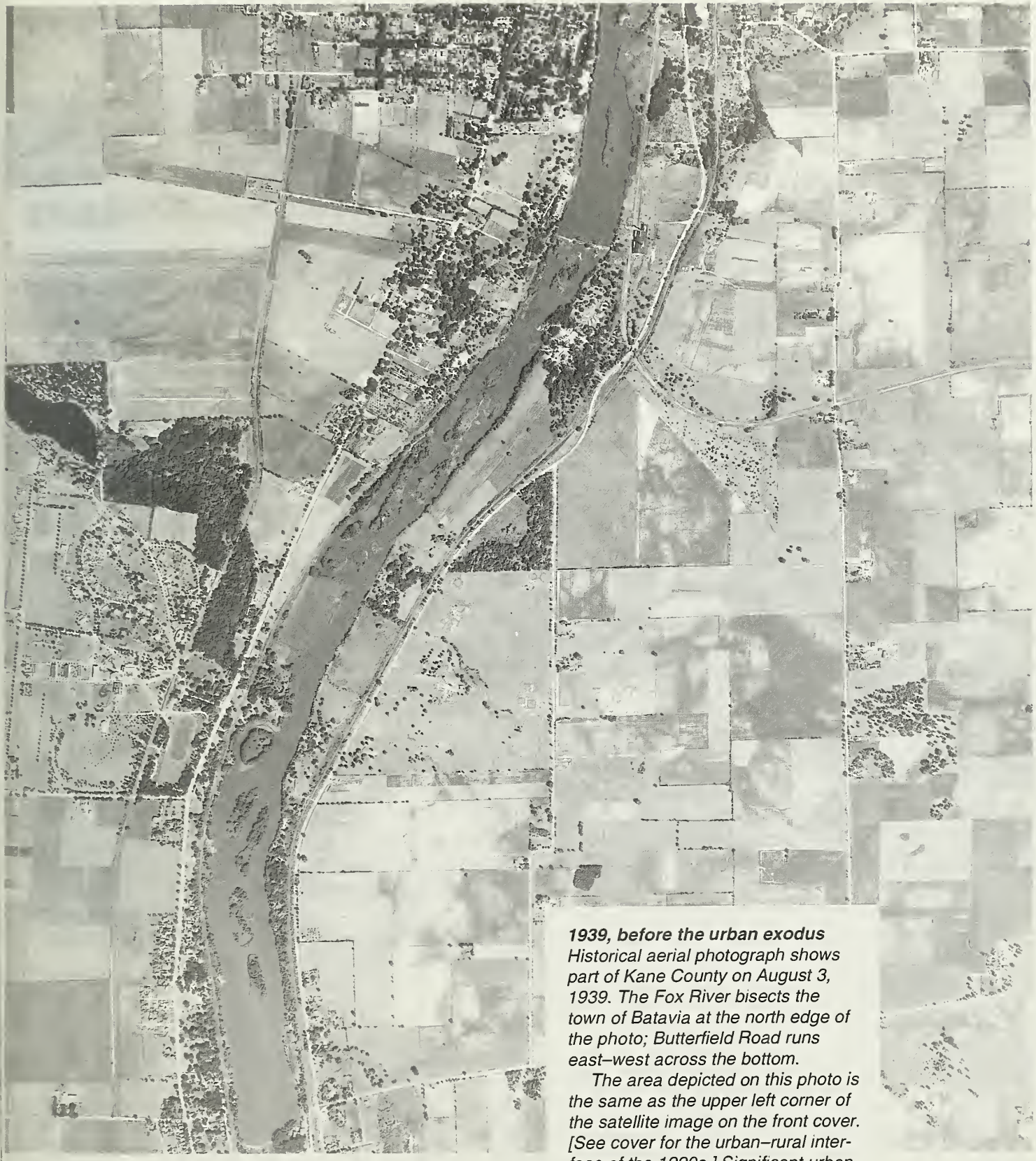
Workers could be exposed to dangerous chemicals or other substances spilled, leaked, or buried in earth materials some time in the past. IDOT has to know the risk of this happening, and calculate the time and costs of removing contaminated materials before starting a project.

When called in on a road project, the GeoSurvey scientists have to find out whatever they can about the property. Was there a coal gas plant there in 1890? A filling station in the 1930s? Or a paint manufacturer in the 1950s? A researcher heads to the archives to dig up old maps, collect historical information about previous land use, and find any existing geologic and hydrogeologic data. This information goes to the project manager, who then interviews local landowners, officials, fire departments, and anyone else with information on the site.

At this point, a subsurface screening of the area is done. In urban areas, the geologists are typically looking for contaminants such as petroleum products, PCBs, heavy metals, or other chemicals. Sites are then given a rating of high, moderate, low, or no risk. Unfortunately, many urban sites end up in the high-risk category, often because of leaking underground storage tanks.

Each year more than 75% of approximately 100 projects are in urban areas, an indicator or the growing importance of urban geology.

- How vulnerable to earthquake damage are towns and cities in and near the New Madrid Seismic Zone? The GeoSurvey's engineering geologists are working with other Midcontinent states to assess the risks and plan for emergencies *[p. 7 and 16].* Because some geologic conditions can amplify ground shaking by as much as a factor of ten, some parts of a city may be more severely damaged than others.
- Gypsum is formed when coal-fired power plants use a wet limestone process to remove sulfur dioxide from flue gases *[p. 11].* GeoSurvey chemists and engineers have developed a process that converts gypsum to ammonium sulfate and precipitated calcium. As granule- size crystals, the ammonium sulfate can be a marketable fertilizer. Now the research is focusing on purification procedures for the calcium carbonate, so it may be marketed as a paper filler or coating.
- The infrastructure of cities in east-central Illinois benefits from the availability of high-quality construction aggregate supplied by the Tuscola stone quarry *[p. 2].* Multidimensional geologic mapping in the Villa Grove quadrangle shows the depth and directional trend of high-quality rock resources.

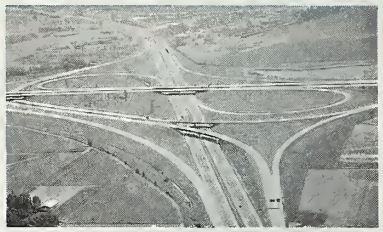


1939, before the urban exodus
Historical aerial photograph shows part of Kane County on August 3, 1939. The Fox River bisects the town of Batavia at the north edge of the photo; Butterfield Road runs east–west across the bottom.

The area depicted on this photo is the same as the upper left corner of the satellite image on the front cover. [See cover for the urban–rural interface of the 1990s.] Significant urban development has occurred in the area since 1939, when the area was mostly farm land. Immediately east of the area on this 1939 photo is the site of the Fermi National Accelerator Laboratory, built in 1972.

Geologic mapping for environmental planning

Communities grow by leaps and bounds. Urban development zips along corridors—once the rivers and railways, now the superhighways—and breaks out some distance from the metro core. New urban nucleii then spread into open land between the corridors and coalesce.

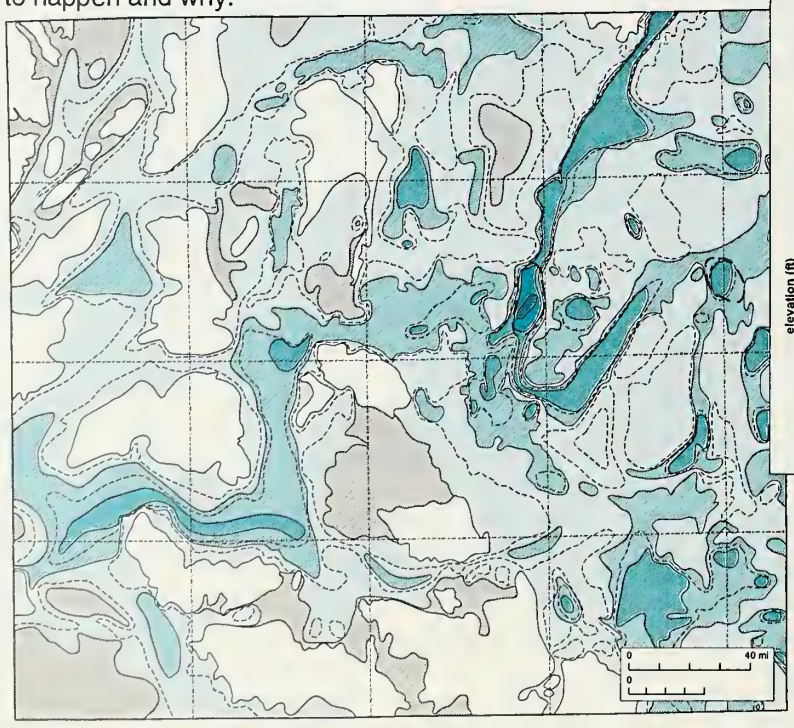


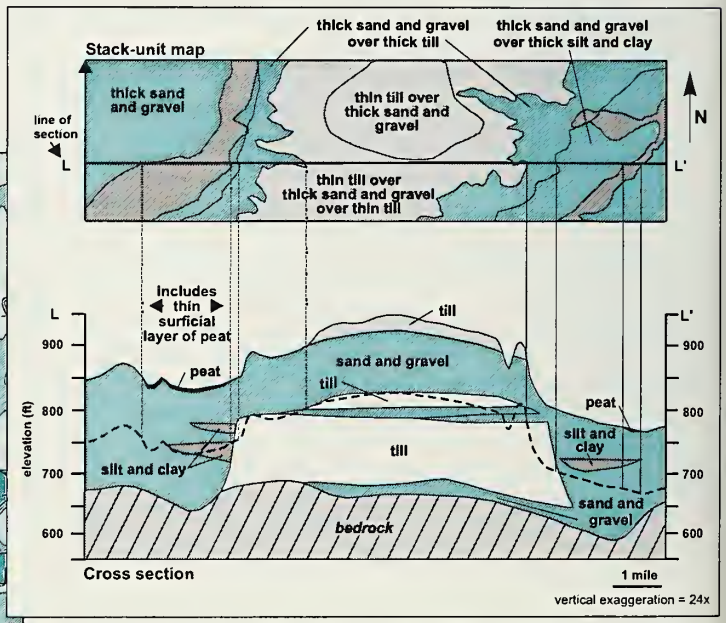
Land-use problems come along with the people surging into the suburbs. Just ask the planning and health departments of Kane, McHenry, Lake, Will, and other counties outside Chicago, or Monroe, Randolph, Madison, and St. Clair Counties across the river from St. Louis. In other parts of the country, communities try to stem the flood when it threatens to break through the city limits and overwhelm what's left of the rural landscape.

But the best defense, say the veterans of county planning commissions in Illinois, is to channel the population flow in the right directions. Plan ahead, they advise. Realize that managing land use really means managing people and their environments, then devise a sweeping strategy for

- developing or maintaining residential, commercial, industrial, and agricultural areas,
- creating or restoring parks, preserves, and natural areas such as wetlands,
- mining deposits of sand, gravel, and stone (construction materials) for buildings and roadways,
- exploring for economic deposits of coal, oil, gas, and critical minerals,
- reclaiming the land for other uses after the mineral or fuel resource is depleted,
- assessing the risk of earthquakes, flooding, landslides, lake shore erosion, and land subsidence,
- siting waste disposal or treatment facilities; deciding which residential areas should be served by city water and sewers and which are suitable for private wells and septic systems;
- locating and protecting groundwater resources.

Geology is basic to every aspect of land use, development, and management. No wonder many county planners are turning to geologists before stretches of natural landscape are bulldozed, dredged out, filled in, built up, and paved over. Through geologic research, the answers are ready and waiting when people ask, "What lies under our towns and farms? Where can we build, mine, bury wastes, or drill for water? Tell us what's likely to happen and why."





Two-dimensional map [left] shows thickness of the aquifers nearest to land surface in McHenry Count. Geologists also create stack-unit maps showing area, depth, and relationship of geologic units from a series of vertical cutaway views, such as cross section L–L' [above] through part of the county. Cross sections are then converted into stack units via a combination of labels and color-coding [top].

Today's geologic mapping programs are detailed, multidimensional, and packed with information on *materials* from soils to bedrock, *resources* from coal to water, *processes* from erosion to earthquakes, and *systems* from natural to concrete watersheds. As a result, the maps, models, and methods devised by GeoSurvey researchers allow counties and communities to expand and transform land-use planning into environmental planning.

Successes of the environmental geology program are many:

- Two pilot projects, multidimensional geologic mapping of the Villa Grove and Vincennes quadrangles in east-central Illinois *[p. 2–5]*, confirm the benefits of combining rock and resource mapping with environmental assessment—in one well-designed package of products.
- New maps also reveal the geologic resources of the Elburn, Geneva, Aurora North, and Sugar Grove quadrangles in northern Illinois and the Alton and Grafton quadrangles in the Metro East region (east of St. Louis) *[p. 6]*.
- McLean and Carroll Counties benefitted from the GeoSurvey's county assistance program *[p. 7]*. They requested and received customized geologic and interpretive maps showing which areas to avoid when siting solid waste facilities and protecting groundwater resources.
- In Monroe and Randolph Counties, mapping the groundwater basins and tracking contamination involved sampling and analysis of water from 15 springs, 30 bedrock wells in the sinkhole plain, and 25 sites in Illinois Caverns *[p. 16]*. Many private septic systems, failing to meet state and local regulations, discharge directly into sinkholes and thus into the local aquifer.
- Unlined hog waste lagoons leak, as a recent GeoSurvey study demonstrated *[p. 17]*. Although researchers found no deterioration of water quality beyond the boundaries of the hog farms, concentrations of ammonia and chlorides were high in monitoring wells near the lagoons. Impermeable liners may be necessary to protect groundwater in some geologic settings.
- Using isotopic analysis, geochemists at the Survey provided clear-cut evidence of the source of contaminants in monitoring wells at several municipal waste landfill sites in Illinois *[p.16]*. The novel approach analyzes for the distinct isotopic signature of landfill leachate and gases.
- Case study: McHenry County's growing population and potential problems with groundwater contamination made updated geologic mapping an urgent need. Where are the aquifer materials, the sand and gravel resources, and the endangered natural areas? At the end of a 3-year

Growing pains: McHenry County *Protecting groundwater resources is what concerns McHenry County most, and with good reason: 80% of the county has aquifers within 50 feet of land surface, which makes them very susceptible, or in the current jargon, "sensitive" to contamination.*

Land-use planning has been standard practice in McHenry County, a Chicago collar county, since its Regional Planning Commission was set up in 1963. The latest update of their all-encompassing plan targets the year 2020. Some of the county's 30 cities and villages even have their own land-use agendas. One village hauled out a vintage 1970 plan last year, when the county okayed some farm land for a gravel pit outside of town. (Since 1975, McHenry County has been the number-one producer of sand and gravel in Illinois. The county has 3,572 acres of land devoted to the business of aggregate extraction.)

McHenry 's head count went from 183,200 in 1970 to 235,000 in 1997, but it's still a largely rural county: 75% farm land and only 7% urban. (Wetlands, forest, and open water make up the rest.) "We've seen dramatic growth in the last 10 years—almost all in the eastern half of the county," says one planner, "so we need to know what's sitting under there."

Enter the State Geological and Water Surveys, at the invitation of the County Health Department, to conduct a thorough study of earth materials (clay, silt, sand and gravel) and groundwater flow systems.

The report, Geologic Mapping for Environmental Planning in McHenry County, *includes maps and cross sections (vertical cuts) of the geologic materials underlying the region. Special "stack-unit" maps show how thick and widespread each layer of material is between land surface and 100 feet deep. Stack-unit maps, important tools for regional planning, are especially useful for locating and protecting groundwater supplies. Once planners know where the aquifers are and what lies above, below, and beside them, they can assess how vulnerable each aquifer is to contamination.*

study, the Illinois GeoSurvey is delivering a comprehensive report and a suite of geologic maps—including a valuable map rating the contamination potential of the county's aquifers.

- Helping the Champaign County village of Homer find a good location for another water well called for a tried-and-true geophysical method called EER, electrical earth resistivity *[p. 18]*. The outcome was highly successful. Test drilling revealed, about 50 feet down, a 100-foot-thick deposit of coarse sand and gravel that yields a strong, steady 195 gallons of water per minute.
- The latest technology, a 3-D computer model of the groundwater geology under 1,000 square miles of McLean and Tazewell Counties, is helping Bloomington–Normal locate a site for a new well field. Additional water supplies are needed to support the growth in population and industry anticipated for the early 21st century *[p. 8]*. The desired yield is 15 to 20 million gallons of water per day.
- Contamination showing up in a wetland is likely to endanger the plants and animals in the area, and eventually, the people tapping into the same groundwater source. Starting with a natural wetland in Vermilion County (one of 11 sites slated for study), GeoSurvey chemists are developing water chemistry profiles that will give researchers a baseline for monitoring changes in water quality *[p. 14]*. The data will also be useful to agencies such as the Illinois Environmental Protection Agency, which sets guidelines for water quality.

Jim Miner

Wetland on the border between McHenry and Cook Counties *In the Chicago metro region, residential, commercial, and industrial development used to run right over wetlands. Now these natural areas are protected for our good—to improve water quality and restore unique plant and animal communities.*

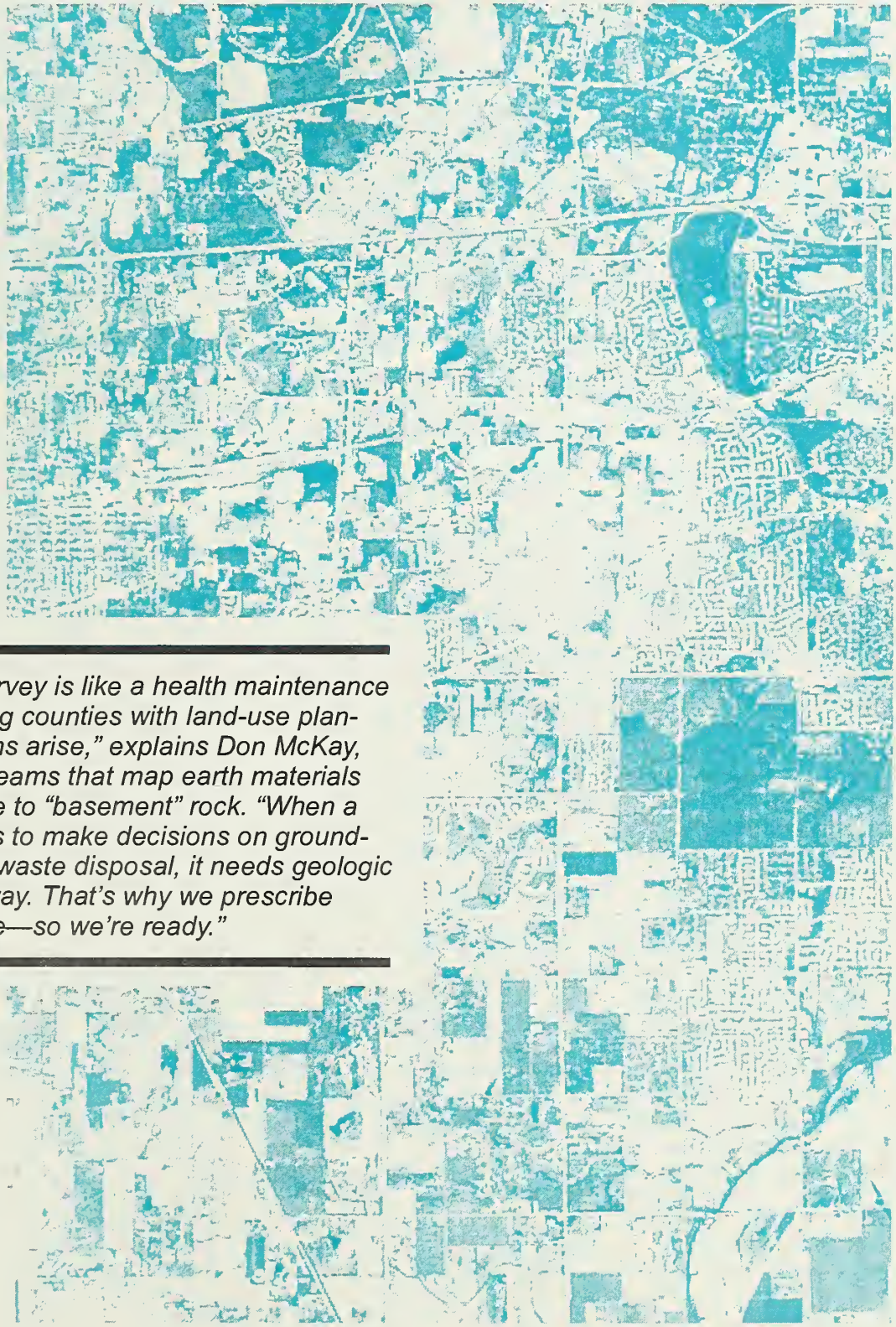
Urban wetlands are plagued with problems, as geologist Jim Miner [left] explains. Pollutants top the list—salt, oils, and heavy metals from roadways, effluent from septic systems, and discharge from sewage treatment plants. One major facility releases water high in fecal coliform and total dissolved solids directly into an Illinois nature preserve.

Rivaling the pollution problem is runoff from paved-over areas. Storm water surging from a paved watershed into a stream is fast and dirty. It doesn't get a chance to percolate through earth before discharging into local streams or wetlands. So peak flows are higher and base flows lower in built-up urban areas than in rural watersheds.

In rapidly developing areas of McHenry, Du Page, Lake, and Will Counties, the Illinois GeoSurvey is working on wetland projects for the Illinois Department of Transportation. Whenever roadbuilding or repair disturbs a wetland, IDOT has to restore or create a wetland elsewhere. That's why the State Geological Survey got involved. Although wetlands are traditionally classified according to type of vegetation, they are really governed by water and geology—the hydrogeology—of an area.

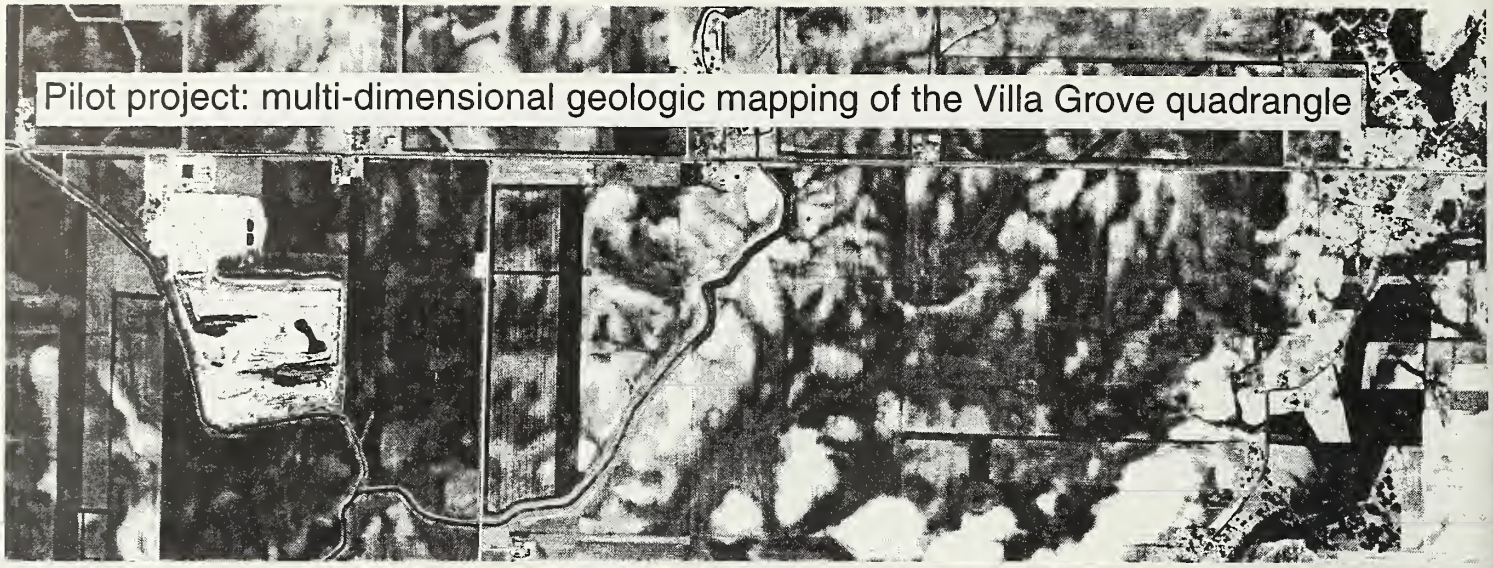
Now, by helping IDOT fulfill their obligations to preserve or restore these natural areas, Jim Miner and his colleagues are gaining valuable experience that the Illinois Department of Natural Resources (DNR) expects to put to good use. If a development project is likely to affect a wetland or nature preserve, the Geological and Water Surveys will supply DNR with information on the local hydrogeology. The goal is to minimize the impact of development on natural areas.

Healthcare program for land—geologic mapping



"The Geological Survey is like a health maintenance organization, helping counties with land-use planning before problems arise," explains Don McKay, director of several teams that map earth materials from ground surface to "basement" rock. "When a city or county needs to make decisions on groundwater protection or waste disposal, it needs geologic information right away. That's why we prescribe mapping in advance—so we're ready."

Pilot project: multi-dimensional geologic mapping of the Villa Grove quadrangle



Geologic mapping—raw material for land-use planning

Villa Grove quadrangle mapping team

In July, a geo-mapping field trip through the Villa Grove and Tuscola region gave local people the opportunity to speak out about land-use issues critical to them:

Groundwater Mostly in short supply, the water also smells and tastes bad in some places. Where and how deep should they drill for a good supply? How can they keep it safe from contamination?

Flooding Why does it happen—geologically speaking? Can restoration of wetlands ease the flooding?

Development What earth materials are suitable for sites of new houses, septic systems, landfills, shopping malls, and industrial parks?

Coal, oil, and gas resources Are any deposits worth developing? Several pipelines cross the area—any geologic risks?

Crushed stone resources The big quarry means jobs, income, and lower taxes for the region. What are the long-term prospects for supplying the mid-state market?

Without in-depth data on the earth (geologic information), locating water supplies, waste disposal sites, and mineral resources is hit or miss.

Quarry opens window to underworld, drilling probes depths

Zak Lasemi, Don Mikulic, Pius Weibel

A 450-foot-deep test hole in the southeast corner of the Villa Grove quadrangle bored through silt, clay, sand, and gravel (materials dating back to the "Ice Age") into shale, siltstone, sandstone, and coal from Pennsylvanian swamps and forests of 300–315 million years ago.

A 1,000-foot-deep hole 1½ miles north of the Tuscola stone quarry bit into rocks 360–440 million years old: first came Ice Age deposits, then New Albany shale (excellent oil source rock), Devonian limestone-dolomite (good crushed stone), Silurian dolomite (best crushed stone), and Maquoketa shale (potential source rock for oil and gas).

Given the information from this test hole and observations of rock formations in the nearby quarry, the State's geologists have a unique opportunity to develop a regional reference section for the oil-rich Silurian and Devonian rocks, elsewhere buried deep within the Illinois Basin.

Rock exposed in the quarry walls, coal tests, oil-and-gas tests, water-well records from GeoSurvey files, and the current drill-hole data—all point to a rich resource base.

Geologic mapping matched with mineral economics

Subhash Bhagwat

The Tuscola quarry serves Vermilion, Champaign, De Witt, Piatt, Macon, Moultrie, Shelby, Douglas, Edgar, Coles, Cumberland, and Clark Counties. The annual production of stone from all quarries in the 12-county region is about 3 million tons, nearly matching our estimates of demand—about 2.7 million tons.

Major cities in the region are Champaign–Urbana, Decatur, Danville, and Mattoon–Charleston. Area highways include interstates 57, 70, 72, 74 and U.S. routes 36, 45, 51, and 150. There's also an intricate network of county roads and thousands of miles of inner city streets. This infrastructure and the industrial, commercial, and residential construction in the region represent a stable demand for stone.

But the cost of supplying stone rises rapidly for every mile it's trucked from the quarry. Thirty miles from the quarry, the delivered price of crushed stone is twice what it is at the pit; 40 to 50 miles away, the price triples.

Aggregate materials such as crushed stone and concrete mixes can be 10% of the cost of road construction. Doubling the price of stone can raise the cost of roads and the public payout for infrastructure. A local source of stone keeps costs down and boosts the local economy.

On top of old bedrock, "Ice Age" quilt, 45 to 150 feet thick

Ardith Hansel Dick Berg

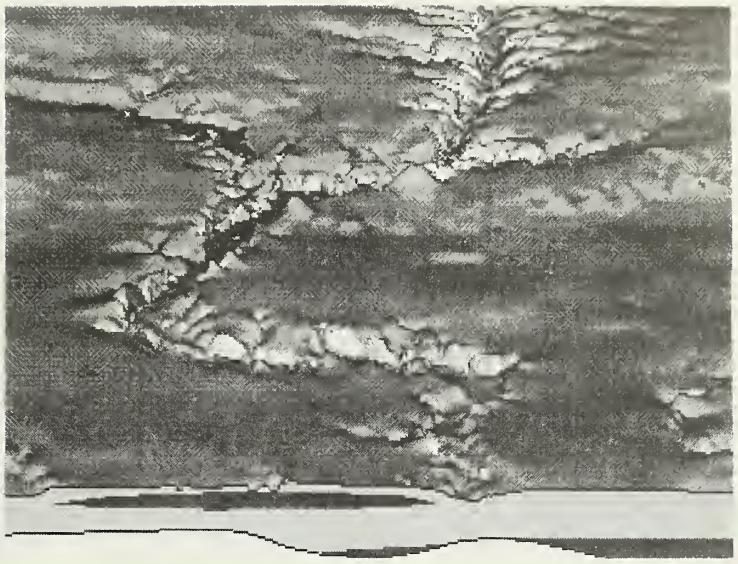
Several 50-foot-deep drill holes in the Villa Grove quad yielded data on Ice Age deposits.

Over bedrock at the Tuscola quarry lies 35–40 feet of till, a mix of sand, silt, clay, and rocks deposited by glaciers, and soils that formed when the glaciers crossed the area. These deposits are evidence for at least three glacial and three interglacial episodes in the midcontinent.

The two main types of glacier materials in the quad are the tills and silty, glacial lake sediments. Although lake "muck" holds a lot of water, its silt and clay particles are too small and tightly packed to let water flow through fast enough to supply wells.

Scattered throughout the quad are thin lenses of sand and gravel that separate tills of different glacial episodes. These deposits supply water to domestic wells, mainly large-diameter, bored wells that collect water seeping in from thin sands.

Sinuous sand and gravel bodies fill glacial streambeds in some places. One small, buried streambed about 90 feet deep in the center of the quadrangle supplies Camargo with up to 75 gallons of water per minute.



Large underground reservoirs of water in Villa Grove quad?

Pius Weibel, Beverly Herzog, Ross Brower

Buried valleys eroded into the bedrock and filled with sand and gravel are most likely to hold sizable water supplies. The largely unexplored Pesotum Valley, buried about 250 feet deep, straddles the north edge of the Villa Grove quad. Longview's well pumps more than 50 gallons per minute (gpm) from aquifers in the valley. Similar aquifers in a tributary bedrock valley in the Newman area supply a few wells with 200 to 350 gpm of water.

Recent geologic mapping of the Villa Grove quad at 1:24,000 scale (1 inch on the map represents 2,000 feet on the ground) reveals another bedrock valley underlying the eastern part of the quad. Well records indicate some sand and gravel in the valley; these deposits should be explored for their water potential.

What's a quadrangle or "quad"?

In geologic mapping, a quadrangle is a four-sided tract of land bounded by parallel lines of latitude and longitude. The size of a quadrangle can be given in minutes: a 7.5-minute quadrangle map, at a scale of 1:24,000, has dimensions of 7.5 minutes for both latitude and longitude.

Water supplies from bedrock—not for low-salt diets

Beverly Herzog, Ross Brower, Tim Young

Cracks and holes in bedrock like the dolomites at the Tuscola quarry or the younger shales to the east may hold enough water to supply wells. In the western third of the Villa Grove quad, dolomites at the surface and deeper (400–450 feet) supply drinking water. In the eastern two-thirds, shallow shales interbedded with thin sandstone and coal yield limited supplies, and at some sites, not enough for a typical household.

In the northern fifth of the quad, yield from the dolomites is better, and usable water can be found at greater depths. Below 200–475 feet deep elsewhere in the eastern third of the quad, water is highly mineralized. A test well near Camargo drew water from 600 feet deep, but the total dissolved solids content was more than 6,000 parts per million. So Camargo gets water from a shallow well finished in a coal bed and two wells in "Ice Age" sand and gravel.

Villa Grove's water comes from two bedrock wells deeper than 600 feet. The wells yield up to 425 gpm, but water quality has deteriorated as mineral content has increased. Also the water contains hydrogen sulfide, a gas that smells like rotten eggs.

Be prepared: more facts about aquifers and other earth materials

Dick Berg

Aquifer mapping helps people decide where and how to protect their water from contamination.

Clay-rich tills atop bedrock in the quad transmit rainwater from the ground surface very slowly. Tills tend to remove chemicals, bacteria, and other contaminants from water moving through them. In most of the quad, thick till shields groundwater sources from wastes in landfills, seasonal applications of agricultural chemicals, spills at chemical storage facilities, or leakage from pipelines. The exception is northern Douglas County, where thin layers of sand and gravel about 25 feet deep may be susceptible to contamination.

Properties of earth materials also govern their capacity for supporting foundations, bridge abutments, and other light construction. Bedrock and till are stable and support most structures, particularly on uplands and in well-drained areas. By contrast, fine-grained river sediments and peat are poor materials for supporting structures; they compact when weight is applied. Drainage is also likely to be poor in these materials, and homeowners may have to deal with flooded basements.

What you can't see—the reason for geologic mapping

Villa Grove mapping team

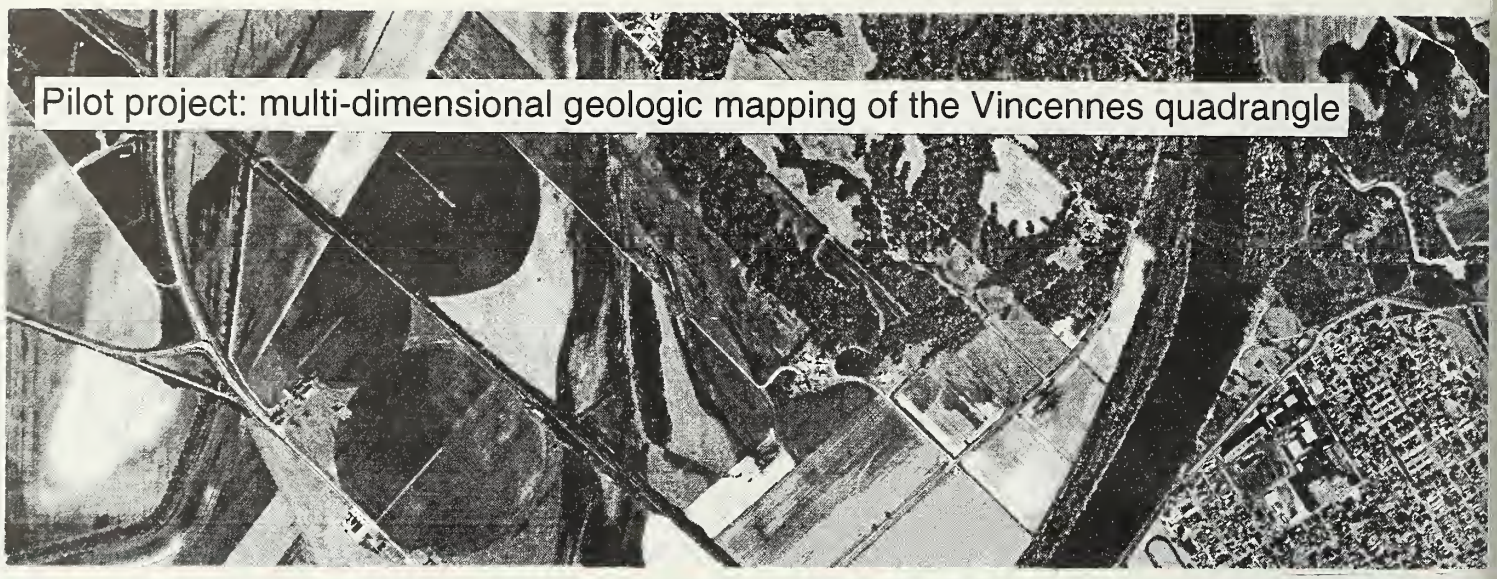
Mapping soil and rocks a few feet to thousands of feet deep isn't easy. Geologists drill holes of various depths, pull up cores of earth materials, run instruments down the holes to test electrical properties of the materials, and subject the cores and samples to a battery of lab tests—all to identify and describe the geologic units underlying land surface. Then they look for what matches among the geologic units at each site. This process, called correlation, gives geologists a 3-D picture of the thickness and distribution of earth materials, some of which are mineral resources (coal, oil, gas, water, crushed stone).

For the Villa Grove mapping, the data from current field work are backed by a database of more than 700 drilling logs—the records of wells and boreholes previously drilled in the quad.

Maps to meet every need:

- Land surface (aerial photo plus topographic contours)
- Earth materials at land surface
- Thickness of glacial materials: clay, silt, sand/gravel on bedrock
- Bedrock surface and geology
- Coal, oil/gas, and crushed stone resources
- Aquifer contamination-potential maps.

Pilot project: multi-dimensional geologic mapping of the Vincennes quadrangle



Geologic mapping—local people ask, what's it good for?

Vincennes quadrangle mapping team

In October, a meeting on geomapping of the quadrangle was held at Vincennes University in Indiana. Local government officials, city engineers, water well drillers, oil consultants, and farmers turned out to hear what the States' geologists planned to do for people living in the quad.

Groundwater Are the quad's abundant supplies especially susceptible to contamination?

Development What earth materials make suitable sites for landfills, subdivisions, shopping malls, and industrial complexes?

Construction aggregate What are the prospects for economic deposits of sand and gravel?

Coal, oil, and gas resources Are any deposits worth developing?

Large-scale, color mosaics of air photos showing the whole region were the hit of the meeting. People could pick out their houses and other familiar land marks, and see the traces of old river channels woven across the floodplain. A mosaic of black-and-white air photos from 1937 provided historical contrast.

Oil resources and deep wells

Dave Morse

Two small oil fields, with their wells now largely plugged and abandoned, are located in the Vincennes quadrangle. The oil was produced from 325-million-year-old sandstone (Aux Vases Formation) and limestone (St. Genevieve Formation) at a depth of about 1,800 feet. Oil is not unusual in Lawrence County. One of the biggest fields in the state lies north and west of nearby Lawrenceville.

As records of more than 100 oil wells in the quadrangle show, several thick coal beds lie between land surface and about 750 feet deep *[see column right]*. The next layers are sandstone and shale, some of which trapped oil. Ages ago, these rocks were sands and clays deposited along the shoreline of a sea. Beneath them are thick layers of limestone that also formed beneath the ancient sea.

The deepest well, a dry hole, reached a depth of 3,576 feet.

Oil wells, when no longer productive, are stripped of pumps and other equipment, then plugged with cement before being abandoned. Plugging protects the groundwater and land surface from contamination by traces of oil or the salty water common in deep bedrock formations.

Coal—buried treasure in the Vincennes quadrangle?

Colin Treworgy

Coal seams, remnants of vast peat swamps that covered this region 300–315 million years ago, lie 250–750 feet deep. In the Villa Grove quadrangle, the Danville, Jamestown, Springfield, Survant, and Seelyville Coals are thick enough for underground mining. But none are currently being mined in the quad, and whether they ever will be depends on the following:

Availability Most rural areas of the quad are ideal for underground mining. But coal under the city of Vincennes cannot be mined because of the potential for costly damage due to subsidence over mined-out areas. The density of oil wells in some parts of the quad may also preclude mining.

Quality No analyses of coals in the quad are available. Nearby in Indiana, the Danville Coal has an attractively low sulfur content. Reports on nearby areas in Indiana indicate that the Jamestown, Springfield, and Survant Coals may also have some lower sulfur deposits.

Cost of mining Coals in the Vincennes quad are slightly thinner and/or deeper than coals currently mined in the rest of the Illinois Basin. The higher cost of mining the Vincennes deposits will discourage development until other deposits are depleted.

Geology shapes culture, not just the landscape

Mike Barnhardt
Don Luman

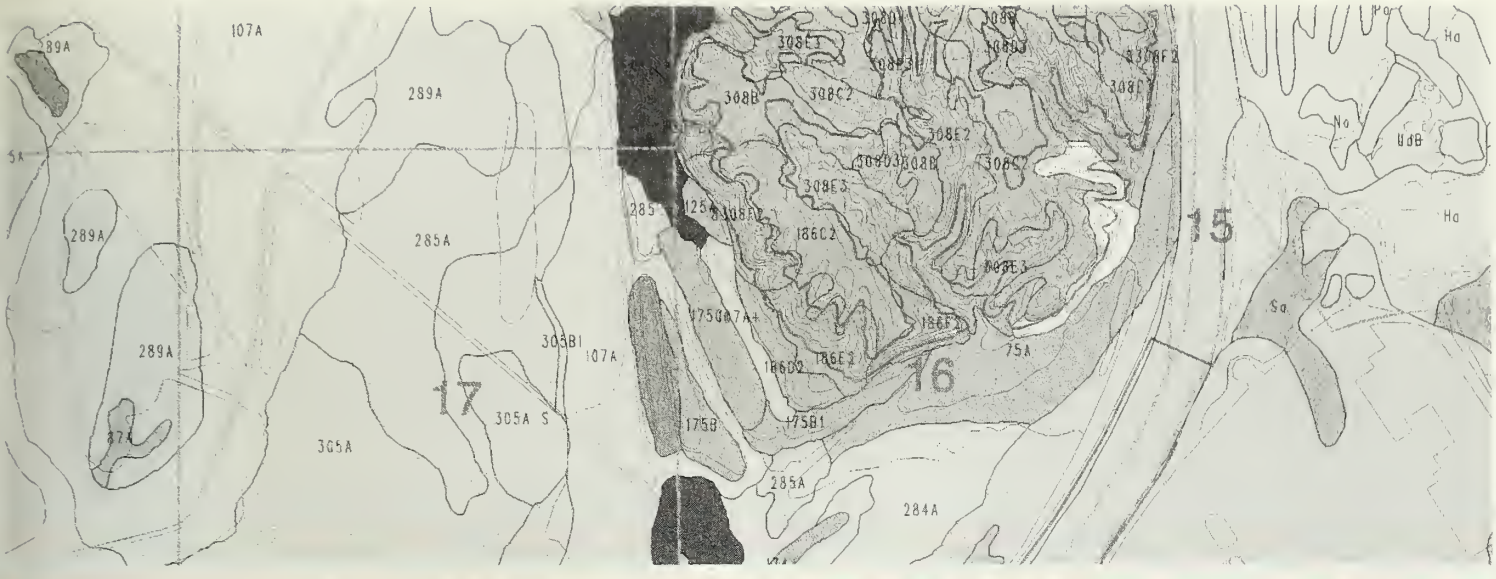
When the glaciers melted, huge volumes of water carrying clay, sand, and gravel flowed southward down the Wabash River system. In the Vincennes quadrangle, which straddles the Illinois–Indiana border, the ancient riverbed deposits of sand and gravel can be more than 100 fee thick and hold substantial quanti ties of water.

Hundreds of high-capacity irri gation wells tap into the coarse sediments for the water necessary to raise corn, soybeans, and vegetables in the well-drained soils of the Wabash Valley. Many wells pump more than 500 gallons of water per minute (gpm) and some as much as 1,000 gpm, even where they're closely spaced.

The present Wabash and Embarras Rivers have deposited silts and clays in low-lying areas that are frequently flooded. So, many older farms on the flood plain sit on higher, better drained sand dunes or stream terraces.

The glacial outwash sands and gravels are surface-mined for construction aggregate to be used in paving roads.

Water wells, gravel pits, oil wells, and test borings all provide data on the glacial sediments—data used to interpret the geologic history of the quadrangle.



Best place to drill for water? A buried bedrock valley

Pius Weibel

Buried under the Wabash River valley is a much larger, bedrock valley more than 6 miles wide. The coarse mix of clay, silt, sand, and gravel in this valley is thicker than 100 feet in places and holds abundant water, enough for irrigation as well as household wells.

These sediments, dating back to the "Ice Age," were largely deposited by glacial meltwater.

In the buried Wabash valley are bedrock "hills" that stand 50–100 feet above the valley floor and rise out of the floodplain. The Robeson Hills in Illinois just northwest of Vincennes, Indiana, were once an island in the ancient river.

Detailed mapping of the bedrock surface shows where rock lies fairly close to land surface and where it's deeper, covered by 100 feet or more of glacial deposits. Thick deposits of water-bearing sand and gravel are more likely to be found where bedrock lies deep below land surface. The map of depth-to-bedrock is valuable for planning where and how deep to drill for groundwater supplies.

Wandering Wabash River, Vincennes quad

Tim Larson

Today the Wabash River flows between Robeson Hills and Vincennes, Indiana. But in glacial times, the river wound around the other side of the Robeson Hills in a course that would have left Vincennes more than 1 mile from the river's banks.

A geophysical technique called seismic refraction, which bounces energy off buried bedrock, helped determine the depth and shape of the old channel. This work, along with geological studies, revealed that the older river channel was probably deeper than the present one.

Thick sand deposits from the old river now are "reservoirs" for an abundant supply of groundwater for highly productive irrigation farming.

Digital image maps combine best features of photos and maps

Don Luman
Mike Barnhardt

Aerial photographs provide a detailed view of the landscape. Those taken in late winter and early spring, before anything is growing, and under optimum drainage conditions can reveal subtle changes that distinguish variations in surface sediments.

In a computer, the image characteristics of an aerial photo, combined with the geometric details of a map, are depicted on the U.S. Geological Survey's digital orthophoto quadrangles. These DOQs, which make it easy to identify and map geologic features, are proving useful to geologists on the Villa Grove and Vincennes mapping teams. They serve beautifully as bases for mapping in the field.

On DOQs, distortions present on ordinary aerial photos have been removed so that ground features are in geographically correct positions. This makes a true image map, and thus permits direct measurement of distances, areas, and angles, and positions of ground features.

Water well and borehole locations, landforms, soils, and cultural features such as towns and farms show up clearly on DOQs. Landowners, city and county planners, and all others interested in land-use issues will find DOQs and DOQ-based geologic maps "easy reading."

Geneva–Elburn metro quads, Kane County: priority for mapping

Dave Grimley
Brandon Curry

In rapidly growing metro regions, community leaders and land developers can use all the geologic information they can get—before the land's totally paved over.

Meeting their need, not a minute too soon, the GeoSurvey has finished mapping earth materials dating back to glacial times (Quaternary) in the Geneva and Elburn quads. Four moraines converge in these quads: the Marengo in the west, the Elburn Complex (really a stagnation moraine) in the center, and the St. Charles and Minooka in the east. The moraines are largely till, a mix of clay, silt, sand, gravel, and a few boulders deposited by the glaciers; but the mix in each moraine is distinctive, from the clayey gray till of the St. Charles and Minooka to the silty-sandy-gravelly material of the Elburn, to the loamy reddish brown till of the Marengo.

The distinctions are critical if you're planning a landfill, septic field, or gas pipeline. You'll want sites with the most impermeable till—thick, tight clay or silt layers that fluids barely move through.

Protecting drinking water depends on confining wastes and other contaminants—keeping them far from your water source.

Sugar Grove–Aurora North quads, Kane County: ditto!

Brandon Curry
Dave Grimley

Geo-mapping headed south to the Sugar Grove and Aurora North quadrangles after the Geneva–Elburn project. What lies below the surface is also important to people in this area:

- The St. Charles Bedrock Valley—a 150-foot-deep buried valley that glacial meltwater carved in the bedrock surface and filled with sand and gravel—yields plentiful water supplies. (This bedrock valley also runs under the Geneva and Elburn quads.)
- Dolomite for construction aggregate (crushed stone) is mined underground, rather than in a traditional open quarry, in North Aurora.
- Thick, clayey till lies between the base of the state-of-the-art Settler's Hill Landfill and a sand-and-gravel aquifer, thus safeguarding groundwater.

Recent mapping synthesizes extensive data from previous GeoSurvey studies, including exploration for shallow groundwater resources and site characterization for the proposed Superconducting Super Collider at Fermi National Accelerator Laboratory.

More than 40 test borings from the ground surface through glacial sediments to bedrock make it easier to map much of the area in detail.

Keep turning out those bedrock maps! Alton and Grafton quads

Joe Devera
Brett Denny

At the confluence of the Illinois, Mississippi, and Missouri Rivers lie the Alton quadrangle, Madison County, and the Grafton quadrangle, Jersey County.

Mapping bedrock in this area took geologists along drainageways, where the region's history is exposed in rock faces. They found horizontal slickensides—evidence for strike-slip faulting when great blocks of bedrock slid past each other in late Paleozoic to Cenozoic times. But surface materials (loess) are not offset, so it's safe to assume nothing has happened recently, not for about 60 million years.

At the surface south of Alton are the Waterloo and Dupo anticlines (arches of rock where oil has been trapped). Some oil wells around Waterloo produce from a formation called the Trenton or Galena Limestone. Possibly, more oil is trapped in smaller anticlines in the Grafton area.

Calcium-rich limestone is quarried for agricultural lime and high-quality crushed stone. The Alton quad has three active quarries—one is underground.

Resource exploration depends on bedrock mapping—one reason the U.S. Geological Survey supports states in this program called STATEMAP.

What's on top—surface maps of Alton and Grafton quads

Dave Grimley

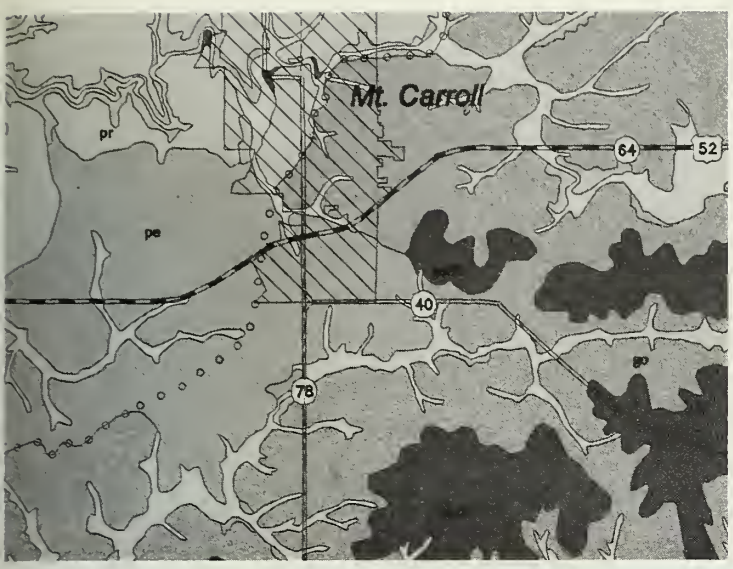
New mapping in the Alton and Grafton quadrangles challenges old ideas about the southernmost reach of glaciation. What geologists found—or rather, did *not* find—was any glacial till in the rocky Grafton quad, where loess (windblown silt) overlies residuum (soil formed in bedrock) and bedrock.

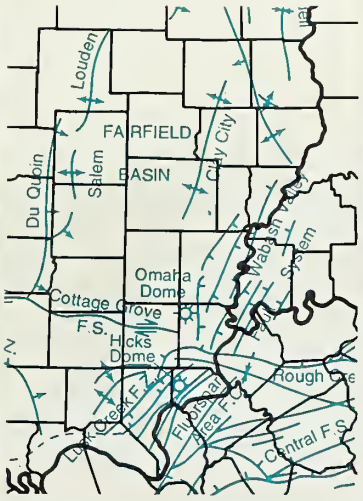
The Alton quad, several miles east of Grafton, has some very tough till (under 15–30 feet of loess), as geologists working the Geoprobe can testify. The Geoprobe is used for drilling through unconsolidated surface materials, which are mostly glacial tills (pebbly clay), sands, and gravels in 80% of the state.

But the ice sheet of the Illinois Episode (next to last glaciation) petered out west of the Alton area and probably never got as far as the Grafton area.

That's how it looks, after drilling two new test holes about 25 feet down to bedrock in the Grafton quad, and seven drill holes as deep as 57 feet to bedrock in the Alton quad. Supporting evidence was found in outcrops, stream and roadcuts, quarries, water well logs, field notes, engineering borings, and previous maps and reports.

Geologists do their homework, as well as field work, to be sure of their maps.





No shortcuts for counties seeking solid waste disposal sites

Rob Krumm, Matt Riggs
Chris McGarry

Counties turn to the GeoSurvey to find out what lies between land surface and bedrock. Which areas of the county are mostly clay, silt, or sand and gravel? How thick and widespread is each deposit? And most important, where are the aquifers—water-yielding sand and gravel or fractured bedrock? Are the aquifers within 50 feet of land surface or buried under impermeable layers at least 100 feet thick?

McLean and Carroll Counties are the latest beneficiaries of the GeoSurvey's county assistance program (CAP), supported by the Illinois Department of Commerce and Community Affairs and participating counties. The CAP's main focus is finding areas to avoid when siting solid waste disposal facilities, but the geologic information from the program is valuable for long-term land-use planning.

The GIS (geographic information system) supports the management of large geologic databases. Maps are used to display information on earth materials, water, and topography. With these maps and 3-D models, community planners can view regional patterns and trends.

Next in line for service are Lee and Jo Daviess Counties.

Win-win: gains from geomapping for counties and research

Dave Grimley
Chris McGarry

Carroll County recently received a map showing its surficial geology in good detail (1:62,500 scale). The map was a compilation of data from previous studies, new drilling, and field work.

The GeoSurvey's database supplied soil reports, field notes, and logs from water well drilling, engineering boreholes, and test borings made by the Illinois Department of Transportation and others. For the current study, geologists selected 23 sites and drilled through surficial materials to depths between 8 and 75 feet, and in many cases, to the bedrock surface.

Field work also involved studies at gravel pits, many small quarries, and road and stream cuts. Samples were collected for grain size analyses, which may help to predict the rate of groundwater flow.

Major findings led to reinterpretation of the limit of glacial till from the Illinois Episode (the second to last glaciation) and the flow directions of glacial ice during the Ice Age.

Maps of the thickness of glacial till, loess, sand, and gravel have many practical applications. They serve to help identify sand and gravel resources and rate aquifers for susceptibility to contamination.

Ice Age earthquakes—discoveries in Illinois

John Nelson

Recent discoveries that surface ruptures have occurred along fault lines in Illinois indicate previously undiscovered earthquake activity during the Ice Age. Geologic mapping in southern Illinois has revealed faults that ruptured and displaced relatively young sediments as recently as the late Wisconsin glacial episode, which ended about 12,000 years ago. This discovery has stimulated further research into the character and extent of these structures and their implications for earthquake hazard assessment.

The faults are in the Fluorspar Area Fault Complex, primarily in Massac County, and in line with the New Madrid fault line in Missouri.

Geologists suspect that these are connected and are investigating to see how the faults in the fluorspar area relate to the New Madrid fault. They want to determine whether any of these faults could set off an earthquake.

GeoSurvey leads regional earthquake risk mapping program

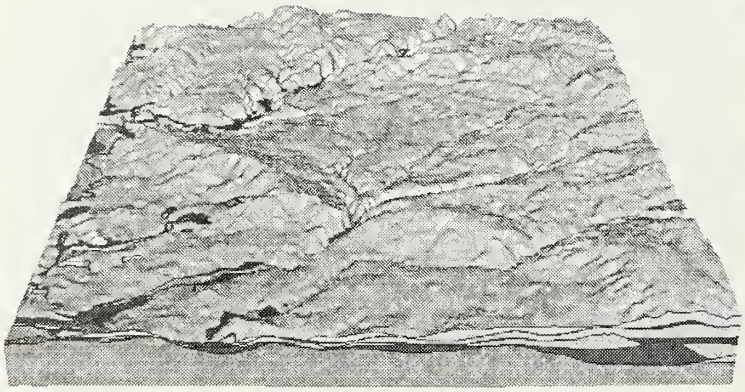
Robert Bauer

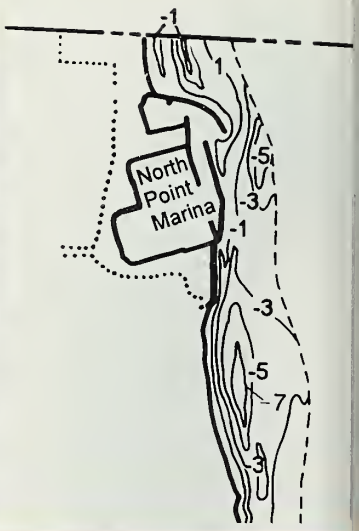
To assess the risk of earthquake damage, geologists must know how local soils will amplify a quake's earth motions. Because soil amplification can cause 3 to 10 times more shaking at the ground surface than at the buried bedrock surface, state and local agencies must know the local soil conditions to plan responses.

To provide this information, the GeoSurvey's engineering geologists are coordinating the Central United States Earthquake Consortium's program to make digital maps in the seven states surrounding the New Madrid Fault Zone.

Working with geologists from other states in the zone, the Illinois GeoSurvey digitized the data to produce the first two earthquake ground motion amplification maps for the Federal Emergency Management Agency.

The first map, at a scale of 1 inch represents 32 miles, covers the entire Midwest. The second, at a scale of 1 inch represents 4 miles, covers the southern third of Illinois; by next year, the rest of the high-risk area will be mapped at this scale.





3-D mapping helps Bloomington locate new water well field

Beverly Herzog, Dave Larson
Curt Abert

Underneath the green surface layer of a 3-D map on a computer screen are blue and sand-colored layers indicating water-yielding earth materials. When the surface layers are electronically peeled off, the contours of the Mahomet–Sankoty aquifer become visible.

With a mouse click, geologists can view geologic features in three dimensions: depth and breadth of the aquifer, bedrock outcrops in the aquifer stream, and old bedrock channels. They can also tell whether channels are filled with nonporous clay or water-bearing sand and gravel.

The 3-D modeling software makes assembling this information on groundwater resources faster and easier than it was in the past. This model of a 1,000-square-mile area in McLean and Tazewell Counties is helping Bloomington identify a well field that can yield 15 to 20 million gallons of water per day.

Using the Geological and Water Surveys' data from several thousand wells, geologists made a map that can be used to plan for the next 20 years.

Another benefit of the project is identifying pathways for recharge to the aquifer—pathways contaminants could also travel.

Getting online map data to your PC—now easier than ever

Dan Nelson
Rob Krumm

More than 1,700 computerized sets of data about Illinois are now available on the Internet. Which are of use to you? Which are up-to-date? How do you get them into your computer?

Solving these problems is made easier thanks to GeoSurvey staff who are leading a cooperative effort of the Illinois Geographic Information System (IGIS).

The IGIS—a group of DNR agencies including the Scientific Surveys—has created the Illinois Natural Resources Geospatial Data Clearinghouse. This Internet site provides documentation and the online digital data that software programs turn into maps and models.

The Internet site is part of the National Spatial Data Infrastructure, a network that is encouraging production and sharing of geospatial data. Users in industry, the public, government, and research can now download into their computers geospatial data about

- nature preserves, wildlife areas, and land cover
- wells, mines, and aquifers
- roads and cities
- groundwater and mineral resources
- soils and geologic material

Visit the website at: http://www.isgs.uiuc.edu/nsdihome/ISGSindex.html

New digital mapping technology applied to recreation site

Mike Barnhardt, Don Luman
Rick Rice, Chris Stohr

A bright green and purple map vividly shows the steepest slopes at Site M, the 16,000-acre Cass County site that the State of Illinois acquired in 1993. When it's overlaid with a map of soil types, potential erosion "hot spots" can be identified. Both maps were generated through new digital mapping techniques.

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Coastal geologists work out sand budget for Illinois' lake shore

Tony Foyle, Mike Chrzastowski
C. Brian Trask

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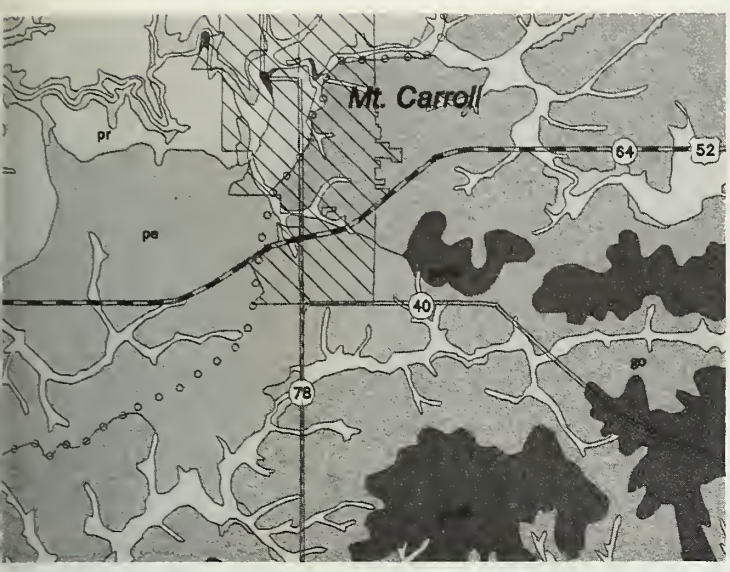
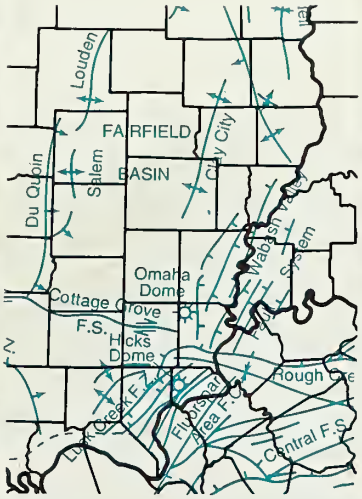




No shortcuts for counties seeking solid waste disposal sites

Rob Krumm, Matt Riggs
Chris McGarry

Counties turn to the GeoSurvey to find out what lies between land surface and bedrock. Which areas of the county are mostly clay, silt, or sand and gravel? How thick and widespread is each deposit? And most important, where are the aquifers—water-yielding sand and gravel or fractured bedrock? Are the aquifers within 50 feet of land surface or buried under impermeable layers at least 100 feet thick?

McLean and Carroll Counties are the latest beneficiaries of the GeoSurvey's county assistance program (CAP), supported by the Illinois Department of Commerce and Community Affairs and participating counties. The CAP's main focus is finding areas to avoid when siting solid waste disposal facilities, but the geologic information from the program is valuable for long-term land-use planning.

The GIS (geographic information system) supports the management of large geologic databases. Maps are used to display information on earth materials, water, and topography. With these maps and 3-D models, community planners can view regional patterns and trends.

Next in line for service are Lee and Jo Daviess Counties.

Win-win: gains from geomapping for counties and research

Dave Grimley
Chris McGarry

Carroll County recently received a map showing its surficial geology in good detail (1:62,500 scale). The map was a compilation of data from previous studies, new drilling, and field work.

The GeoSurvey's database supplied soil reports, field notes, and logs from water well drilling, engineering boreholes, and test borings made by the Illinois Department of Transportation and others. For the current study, geologists selected 23 sites and drilled through surficial materials to depths between 8 and 75 feet, and in many cases, to the bedrock surface.

Field work also involved studies at gravel pits, many small quarries, and road and stream cuts. Samples were collected for grain size analyses, which may help to predict the rate of groundwater flow.

Major findings led to reinterpretation of the limit of glacial till from the Illinois Episode (the second to last glaciation) and the flow directions of glacial ice during the Ice Age.

Maps of the thickness of glacial till, loess, sand, and gravel have many practical applications. They serve to help identify sand and gravel resources and rate aquifers for susceptibility to contamination.

Ice Age earthquakes—discoveries in Illinois

John Nelson

Recent discoveries that surface ruptures have occurred along fault lines in Illinois indicate previously undiscovered earthquake activity during the Ice Age. Geologic mapping in southern Illinois has revealed faults that ruptured and displaced relatively young sediments as recently as the late Wisconsin glacial episode, which ended about 12,000 years ago. This discovery has stimulated further research into the character and extent of these structures and their implications for earthquake hazard assessment.

The faults are in the Fluorspar Area Fault Complex, primarily in Massac County, and in line with the New Madrid fault line in Missouri.

Geologists suspect that these are connected and are investigating to see how the faults in the fluorspar area relate to the New Madrid fault. They want to determine whether any of these faults could set off an earthquake.

GeoSurvey leads regional earthquake risk mapping program

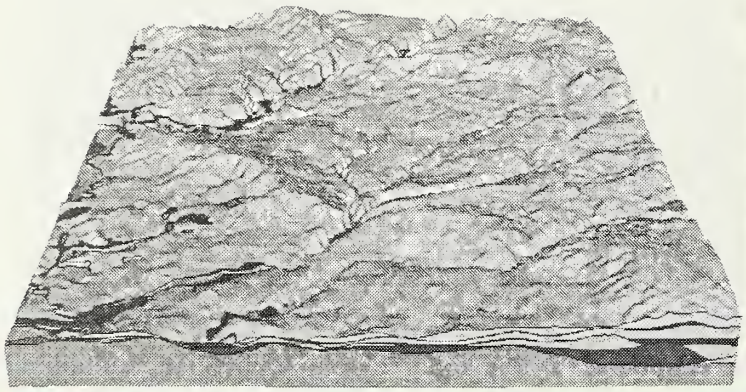
Robert Bauer

To assess the risk of earthquake damage, geologists must know how local soils will amplify a quake's earth motions. Because soil amplification can cause 3 to 10 times more shaking at the ground surface than at the buried bedrock surface, state and local agencies must know the local soil conditions to plan responses.

To provide this information, the GeoSurvey's engineering geologists are coordinating the Central United States Earthquake Consortium's program to make digital maps in the seven states surrounding the New Madrid Fault Zone.

Working with geologists from other states in the zone, the Illinois GeoSurvey digitized the data to produce the first two earthquake ground motion amplification maps for the Federal Emergency Management Agency.

The first map, at a scale of 1 inch represents 32 miles, covers the entire Midwest. The second, at a scale of 1 inch represents 4 miles, covers the southern third of Illinois; by next year, the rest of the high-risk area will be mapped at this scale.



3-D mapping helps Bloomington locate new water well field

Beverly Herzog, Dave Larson
Curt Abert

Underneath the green surface layer of a 3-D map on a computer screen are blue and sand-colored layers indicating water-yielding earth materials. When the surface layers are electronically peeled off, the contours of the Mahomet–Sankoty aquifer become visible.

With a mouse click, geologists can view geologic features in three dimensions: depth and breadth of the aquifer, bedrock outcrops in the aquifer stream, and old bedrock channels. They can also tell whether channels are filled with nonporous clay or water-bearing sand and gravel.

The 3-D modeling software makes assembling this information on groundwater resources faster and easier than it was in the past. This model of a 1,000-square-mile area in McLean and Tazewell Counties is helping Bloomington identify a well field that can yield 15 to 20 million gallons of water per day.

Using the Geological and Water Surveys' data from several thousand wells, geologists made a map that can be used to plan for the next 20 years.

Another benefit of the project is identifying pathways for recharge to the aquifer—pathways contaminants could also travel.

Getting online map data to your PC—now easier than ever

Dan Nelson
Rob Krumm

More than 1,700 computerized sets of data about Illinois are now available on the Internet. Which are of use to you? Which are up-to-date? How do you get them into your computer?

Solving these problems is made easier thanks to GeoSurvey staff who are leading a cooperative effort of the Illinois Geographic Information System (IGIS).

The IGIS—a group of DNR agencies including the Scientific Surveys—has created the Illinois Natural Resources Geospatial Data Clearinghouse. This Internet site provides documentation and the online digital data that software programs turn into maps and models.

The Internet site is part of the National Spatial Data Infrastructure, a network that is encouraging production and sharing of geospatial data. Users in industry, the public, government, and research can now download into their computers geospatial data about

- nature preserves, wildlife areas, and land cover
- wells, mines, and aquifers
- roads and cities
- groundwater and mineral resources
- soils and geologic material

Visit the website at: http://www.isgs.uiuc.edu/nsdihome/ISGSindex.html

New digital mapping technology applied to recreation site

Mike Barnhardt, Don Luman
Rick Rice, Chris Stohr

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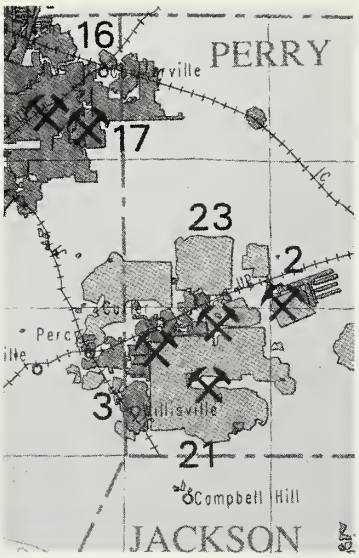
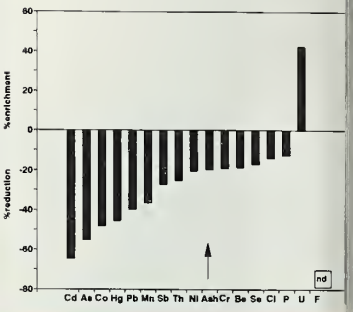
Critical junctures for energy and minerals research

"We have always played a role in the State's coal and industrial minerals development, adapting our research to deal with the problems that emerge," explains senior chemical engineer Massoud Rostam-Abadi, speaking for the minerals engineers and coal researchers at the Geological Survey. "Today, we're dealing with air toxics and pollution control. Our engineers and scientists are working together to find ways to make coal-burning cleaner and more efficient.

"We also want to make marketable products out of the things people throw away or think are waste materials—like ash. 'Ash is cash,' I like to say. Think of wastes as valuable raw materials."

"Oil and gas are 'strategic minerals'—extremely important to the economy. In the last three decades, the U.S. has been dependent on imported oil. We import our energy," says geologist Beverly Seyler, who heads the Geological Survey's petroleum research team. "Today, interest in petroleum exploration is picking up in the U.S. —and in Illinois. Our geologists and engineers are busy handling requests by petroleum companies for our services. Consultations have increased dramatically...."





Coal availability study finds changes in minable amount

Colin Treworgy

Areas east of St. Louis were once considered likely places to strip mine coal. But because of suburban and exurban development in the area, much of the coal here will not be stripminable. Many shallower deposits have been mined out and the amount of material overlying the remaining coal seams is seen as restricting strip mining here. But some of this coal can now be mined by underground methods, thanks to technological improvements that have reduced costs to roughly those of stripmining.

These changes point out a need to reassess the amount of coal actually minable in Illinois. So the GeoSurvey (supported by federal funding) has been compiling data on coal availability at specific sites. The project, part of a major study of coal resources in Illinois, recently focused on the western edge of the Illinois coal basin.

The assessment shows that along the western edge of the Illinois coal field, 60–70% of the coal is not available for mining. Elsewhere in the southwestern part of the state, the figure is only 10–20%. Statewide estimates will be available when the final section of the project is completed next year.

Economic prospects for Illinois coal

Subhash Bhagwat

Illinois coal sales declined from 60 million tons in 1990 to less than 50 million in 1995. This trend is likely to continue through 2010 when sales could fall between 26 and 40 million tons.

The biggest obstacle to marketing Illinois coal is the restriction on sulfur dioxide emissions, part of the federal Clean Air Act (CAA). Most Illinois coal, relatively high in sulfur, suffers an economic disadvantage compared with other fuels—a disadvantage due to the cost of removing sulfur. The major competitor, low-sulfur western coal, is often priced less than Illinois coal, and now natural gas is emerging as a competitor in electric generation.

Utilities that reduce emissions below CAA limits can sell "pollution credits" to utilities exceeding the limits. A credit surplus, due to burning western coal, has driven their price down to the point where plants could economically burn Illinois coal by buying credits. But utilities, looking ahead to 2000 when emissions levels will be capped, are banking them for the day when increased demand for electricity will increase demand for credits.

The situation of Illinois coal is unlikely to change until research finds ways to make it much cheaper to mine, clean, and burn.

Illinois' coal industry at a glance

Heinz Damberger, Barb Stiff
Jennifer Hines

A popular map that provides a quick, clear summary of the coal industry in Illinois received a 13-year update.

The large, 1:500,000-scale, color map shows the extent of coal-bearing Pennsylvanian rock, sites of active mines, and coal-handling docks along rivers, areas mined out by surface or underground mining, and locations of major power, industrial, and institutional coal-burning plants.

Tables and graphics give data on coal mines, coal-burning plants, coal production and consumption, and amounts of coal imported to and exported from Illinois. A comparison with the 1984 map dramatically reveals how much more competitive and efficient the Illinois coal industry has become in 12 years: 45% fewer mines produce only 16% less coal.

The map was produced using the GeoSurvey's computer facilities. Production was supported by the Illinois Department of Commerce and Community Affairs, which will use the map to promote Illinois coal overseas and to educate teachers and students about Illinois coal.

HAPs—hazardous air pollutants from burning Illinois coal?

Ilham Demir, Dick Harvey
Heinz Damberger

All coals contain traces of 16 ele ments identified as "hazardous air pollutants" by the Clean Air Act Amendments of 1990. But concentrations of HAPs vary, often greatly, from coal to coal. The U.S. Environmental Protection Agency (USEPA) has been assessing the health risks due t HAPs escaping into the air when power plants burn coal.

The EPA bases its risk assessment largely on samples of coal-straight-out-of-the-ground. But that's not what Illinois mines ship to utilities. Almost all Illinois mines clean their coals first. So what's the concentration of HAPs in as-shipped coals?

At the GeoSurvey, analyses of more than 220 samples of coal-in-the-ground have been compared with analyses of representative samples of as-shipped, cleaned coals from 34 active mines in Illinois.

Conventional coal-cleaning sharply cuts concentrations of HAPs—on average, by more than 20% for most of these elements, and by 40–60% for highl toxic arsenic, cadmium, cobalt, mercury, and lead.

The findings were submitted to the USEPA to include in its risk assessment study.

"Activated" carbons from Illinois coal zap mercury in flue gases

Shiaoguo Chen
Massoud Rostam-Abadi

Controlling emissions of mercury in flue gases of coal-burning power plants is one of many uses for activated carbons produced from Illinois coal. Minerals engineers at the GeoSurvey and the University of Illinois have developed a product that's likely to outperform commercial carbons—and at a lower cost.

What "activates" carbons? They've been through treatments to open up their pore structure. So each particle has more surface area with more active sites to adsorb ("capture") noxious elements, like mercury, in flue gases.

More than 100 lbs of activated carbon was produced from an Illinois coal run through a fluidized-bed pilot reactor at Svedala in Oak Creek, Wisconsin. Then this carbon material was tested at CONSOL's toxics control pilot plant and two utility demonstration sites sponsored by EPRI (Electric Power Research Institute), and the U.S. Department of Energy.

In these tests for mercury removal, the Illinois coal product matched or topped the performance of a commonly used commercial product. The Illinois activated carbon also has the advantage in production cost: an estimated $400 per ton, or less.

Gypsum byproducts of burning high-sulfur coal may turn a profit

Melissa Chou
John Lytle

When power plants such as the University of Illinois' Abbott plant burn high-sulfur coal, they remove sulfur from the flue gases. Abbott uses a wet limestone process. Although effective at removing sulfur dioxide (SO_2), the process also produces a lot of solid gypsum, a combination of calcium, sulfur, and water.

Chemists and engineers at the GeoSurvey have developed a process that converts gypsum to ammonium sulfate and a byproduct of precipitated calcium carbonate. As granule-size crystals, the ammonium sulfate can be a marketable fertilizer.

Commercial applications of precipitated calcium carbonate came under study next. Specifications for industrial use focus on particle size (fineness), whiteness, and the mineral and chemical purity. After testing methods to remove impurities in gypsum from the Abbott plant, researchers made two recommendations: use limestone with few impurities for flue-gas desulfurization, or purify the gypsum byproduct to get the desired whiteness.

Now they're modifying reaction conditions such as temperature, processing time, and mixing speed to control fineness of particles, and purification procedures to produce a calcium carbonate paper filler or coating.

Steady demand for Illinois Basin coals—for research

Chusak Chaven
John Lytle

That's why the Illinois GeoSurvey has a coal "bank."

When researchers in the state and around the world use Illinois Basin coals, they want representative, well-preserved samples. They expect that the coal they request for study, analyses, or experiments in 1 or more years from now will be the same in quality as the coal they obtain from the GeoSurvey today.

Samples from several seams in Illinois and a few from Indiana are stored in a nitrogen atmosphere to minimize oxidation. If exposed to air, the coals would change in ways that made them undesirable for controlled experiments.

In 1996–1997, 1,500 lbs of coal from 12 lots were delivered to fill 20 requests: 14 came from other government agencies, 3 from states other than Illinois, and 3 from foreign countries.

Complete data on physical and chemical properties are available for all coals in the Illinois Basin Coal Sample Program. Look for this information soon on the Illinois GeoSurvey's website:

http://www.isgs.uiuc.edu

Sand dunes in Kankakee County—economic potential?

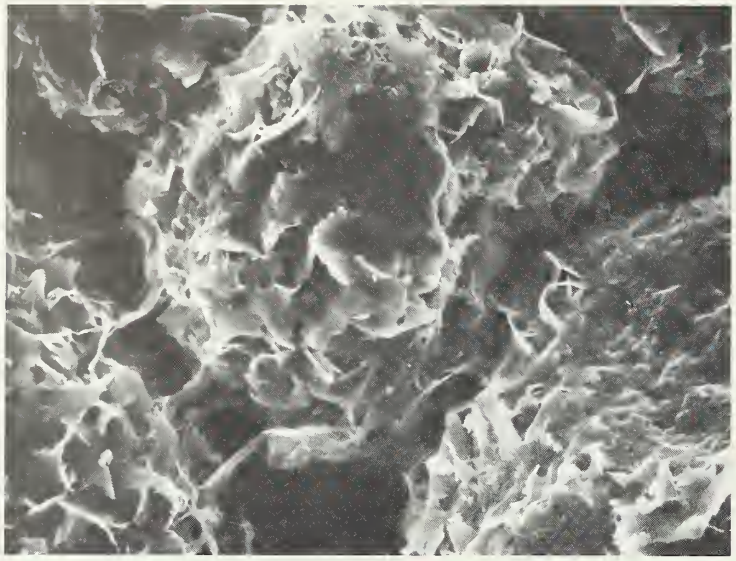
Subhash Bhagwat, Jack Masters
Randy Hughes, Viju Ipe

When you hike over the last ridge of dunes, you won't find an oasis. This dune field was created by winds blowing sand off a glacial outwash plain about 12,000 years ago.

All that sand—what could be made and marketed from this abundant earth resource? The county's Economic Development Council asked the GeoSurvey to check out its mineral value and processing potential.

On test sites volunteered by two landowners, the field team drilled five holes 20 to 35 feet deep and collected samples for analysis. Now if the GeoSurvey's mineral engineers can come up with a way to clean out the clay, iron-rich minerals, and rock fragments, the quartz-feldspar mix might be used to make amber glass. In fact, a similar dune field in Mason County supplies sand to a plant that makes bottles.

Once an amber glass process is completed, the project team will see whether separation of quartz from feldspar could produce higher value materials for pottery, electrical insulators, and other ceramic products.



Unique clay mineral may help oil exploration

Dewey Moore

Finding oil reservoirs in the Aux Vases and Cypress Sandstones in Illinois is difficult, and geologists look for clues that indicate likely spots. One potential clue recently uncovered by the GeoSurvey's clay mineralogists is an unusual chlorite clay mineral. Although clay minerals may make up only 2–5% of the total mineral content in these sandstone formations, it forms a very thin coat on the sand grains. This seems to prevent the growth of quartz crystals that could fill in the pores between grains. Otherwise commonly seen in sandstone, this growth reduces the porosity necessary for oil or gas to be present.

The clay minerals geologists recognized the chlorite mineral in these sandstone formations as one never before seen in the Illinois Basin. They have since compared the Aux Vases and Cypress samples with chlorite-containing sandstones from petroleum provinces around the world and found that all of them have this same peculiar type of chlorite clay mineral.

Finding this mineral will help in the exploration of oil in Illinois.

Pollution control one of many uses for mineral ID method

Randy Hughes, Dewey Moore

Determining the exact composition of key minerals is a major problem when removing toxic pollutants from coal, making bricks with fly ash from coal combustion, or designing the clean-up of a hazardous waste site.

GeoSurvey scientists have developed a new procedure to obtain precise compositions that help solve these problems. The procedure sequentially dissolves individual minerals in acids. The method can, for example, distinguish the toxic elements in coal from those in its mineral matter. This can then be used to design better coal-cleaning processes.

The procedure is being used to determine how to best contain heavy metal pollutants in wastes at an abandoned zinc smelter in Bureau County. The procedure is also proving useful as a relatively inexpensive and precise method of mapping metals in deep geologic strata.

This method was developed for determining precise mineralogical formulas, a task that can be very difficult in mixtures of minerals. Many applications of the method are in the early testing stages, but the continuing value of this method for research is assured.

New model of Aux Vases Sandstone will aid exploration

Hannes Leetaru

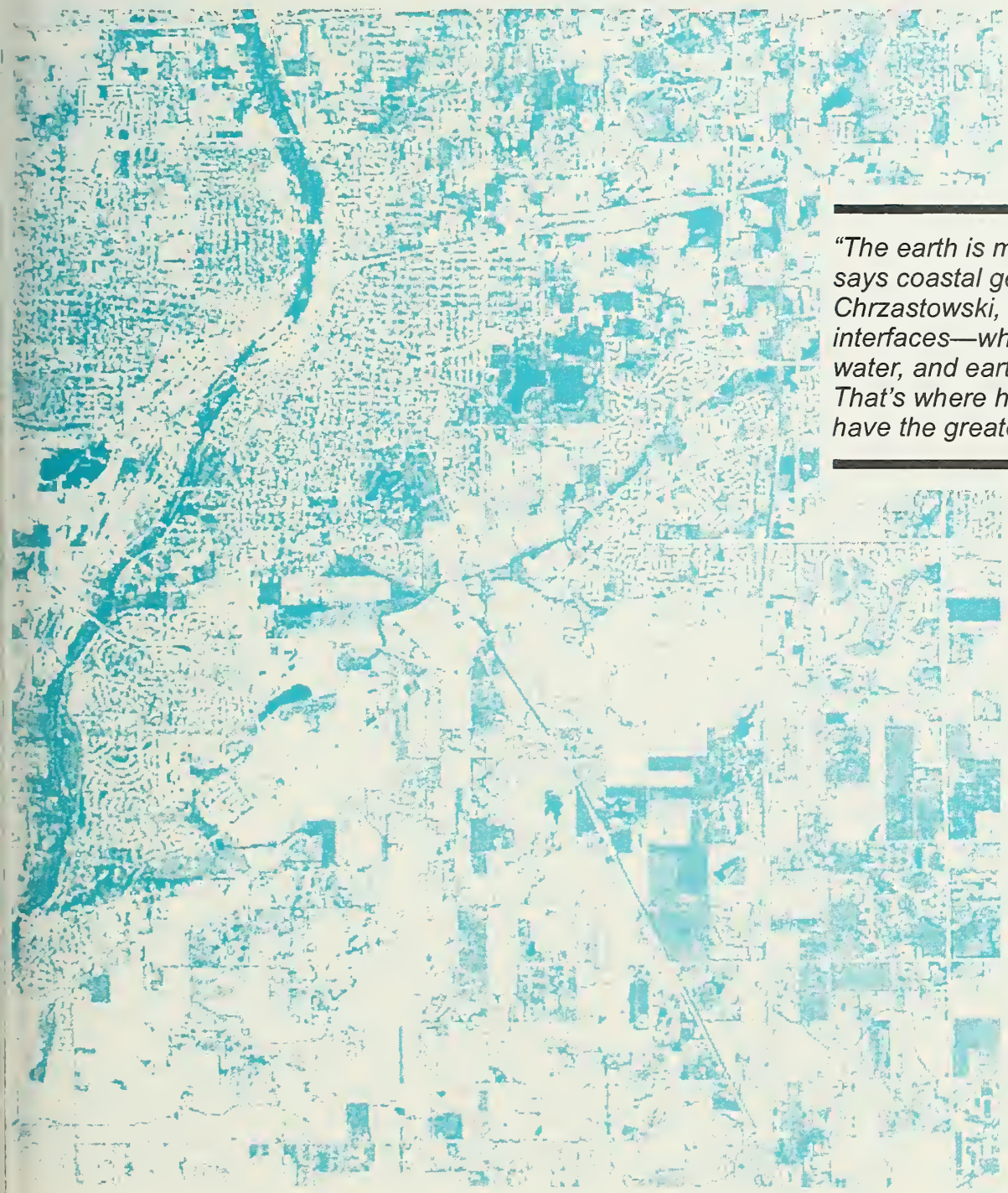
The Aux Vases Sandstone is an important aquifer in southern Illinois. Also, 10–25% of Illinois oil comes from the Aux Vases; it supplies quarry stone in southeastern Illinois; and much of the fluorspar in the United States was recovered from rocks directly below the Aux Vases.

The GeoSurvey has developed a new model of the creation of the formation—one that explains how everything in it fits together. Understanding how things fit will be a huge help in looking for oil, water, quarry stone, and fluorspar—all valuable to Illinois.

By applying the relatively new methodology of sequence stratigraphy to analyze the rocks, the GeoSurvey's petroleum geologists were able to see how different parts of the formation are related. For instance, the model shows how the channels in the western part of the formation are related to the tidal flats in the eastern area. It also shows how the formation was deposited. This will aid in the exploration and development of oil, water, and quarry stone.

The study provides information that can help find resources and indicate the problems that might occur when trying to extract them.

Environmental protection—everybody's business



"The earth is most vulnerable," says coastal geologist Mike Chrzastowski, "at its dynamic interfaces—where atmosphere, water, and earth interact. That's where human activities have the greatest impact."

Groundwater pollution threat assessed for nature preserves

Richard Berg
Mike Miller

The Illinois Nature Preserve Commission, aware that many of the more than 1,300 nature preserves and natural heritage areas around the state are in danger of contamination from groundwater, asked the GeoSurvey and Water Survey to rate their sites according to the level of contamination threat.

During the past 3 years, scientists from the surveys have visited more than 80 nature preserves and recently finished a study that assesses the vulnerability of wetlands within the preserves from contaminated groundwater from surrounding areas. The preserves were rated from low to high vulnerability based on geology and land uses both on and off the site. From now on, groundwater that contributes to nature preserves will be required to meet more stringent and site-specific standards than regular standards.

The project will provide land managers with needed information on what potential hazards exist, and when hazards begin to impinge on sites, whom to call for help. The project is a good example of cooperation among the State's Scientific Surveys.

Wetland creation and restoration guide to help land managers

Mike Miller

Farmers, developers, government agencies, and citizens who have to deal with wetlands in Illinois know what a problem it can be, not only with the physical aspects of the land, but particularly with the regulatory framework that covers wetlands.

To help these people, the Illinois Wetland Restoration and Creation Guide was published in 1997 after 5 years of effort by the Geological and Water Surveys, other agencies within the Illinois Department of Natural Resources, and the Illinois Department of Transportation. The guide helps land managers characterize, monitor, and manage wetlands.

The guide contains two levels of information. The first details actions that most people can take to better manage wetlands. The second lays out how to identify the variety of problems and issues for which a land manager needs to call a professional with specific wetland science expertise. The guide also describes the regulatory framework that managers need to know when working on wetlands. It emphasizes overall restoration and creation processes and gives information for carrying out each stage of the project, as well as where to go for detailed information on particular problems.

Wetland chemistry data baseline being built

Rich Cahill
Gary Salmon

Wetland water chemistry profiles provide a much-needed baseline to evalute change through time and identify threats to wetlands. But before 1992, water chemistry information for most Illinois wetlands was limited.

Since then, GeoSurvey chemists have been involved with other agencies in collecting and analyzing data from wetlands. These data should assist the Illinois Environmental Protection Agency to establish wetland water-quality guidelines.

The project began when information on changes to wetlands was required during a freeway construction project near Chicago. To assess changes, the chemists needed a natural wetlands site, and a Vermilion county site was selected. Since then, 11 other sites have been added to the project to build the database.

Recent findings are that the wetlands by the freeway are suffering high chloride levels from road salt. At the Vermilion County site, elevated levels of nitrates, possibly from agricultural runoff, were detected. The findings serve as the first clue that something is happening in the wetlands and alert wetland managers to keep watch for changes in the plant environment.

Pollution watch: west branch of the Grand Calumet River

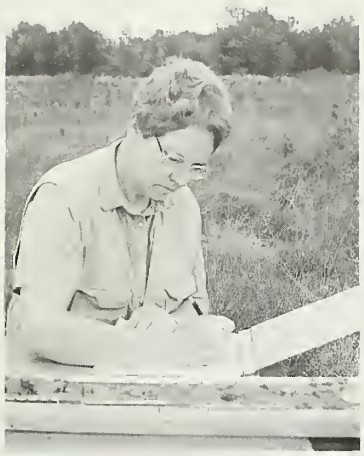
Rich Cahill

What are sedimentation rates—that is, how fast do noxious substances in the slow-flowing rive settle into the river bed?

Thanks to heavy industry an shipping, the Illinois–Indiana te ritory south of Lake Michigan lo its pristine nature long ago. The Illinois GeoSurvey and the San tation District of Hammond hav joined in an ongoing program t evaluate contaminated zones. Armed with facts, the U.S. Envi onmental Protection Agency an U.S. Army Corps of Engineers can focus dredging and remedi tion of polluted sediments wher efforts will do the most good.

At ten locations along the west branch of the Grand Calumet River, researchers collecte composited sediment cores, su samples of cores from discrete intervals, and surface "grab" samples. They determined the organic carbon content of 162 subsamples and concentrations of 26 elements in selected subsamples. Using analyses of dis crete subsamples, they plotted concentrations by depth and lo cation. Sedimentation rates we also calculated for all locations.

High levels of organic carbo and trace elements are confine between river miles 5 and 7.5. Contamination of this part of th river dates back to the1930s.



Urban geology—roadways checked out for earth hazards

Phyllis Bannon, Anne Erdmann
Site assessment team

When doing road work through areas that were industrial or commercial sites, IDOT (Illinois Department of Transportation) workers could be exposed to dangerous chemicals. Was there a coal gas plant there in 1890? A filling station in the 1930s? Or a paint manufacturer in the 1950s? If so, the project might suffer costly delays while contaminated soils are removed.

IDOT has to know the risk before starting work, so the GeoSurvey's environmental site assessments team is called in to make preliminary assessments. More than 75% of about 100 assessments each year are in urban areas, a number reflecting the increasing need for "urban geology."

When called in, a GeoSurvey researcher heads to the archives to dig up maps—some dating back to the 19th century—and collect historical land-use information and geologic and hydrogeologic data. The project manager interviews local landowners and officials, who might have information about the site, before doing a subsurface screening of the area *[see column, right]*. In urban areas, contaminants such as petroleum products, PCBs, and heavy metals often lead to a high risk rating.

Environmental site assessment team aids IDOT

Bob Bauer
Site assessment team

GeoSurvey engineering geologists and specialists in environmental site assessments often spend time drilling holes to look for a "real pretty color of green" soil and hoping they don't find it. "Green soil" is an almost sure sign of gasoline contamination.

Finding contamination may mean work and expense for the IDOT, which contracts with the GeoSurvey to identify potential manmade and natural hazards along state highways slated for improvement *[see column, left]*. The scientists drill at suspected contaminated sites and check for volatile organic compounds and chlorinated compounds using gas analyzers and field kits.

Last spring, team members were finding no contamination along a state road near Beardstown. But they are not always so lucky. Shortly before that, almost every hole dug along a Chicago area artery showed contamination. Besides looking for soil contaminants, the scientists also look for natural earth hazards such as landslides.

While costly in the short run, these assessments save the State of Illinois lots of time and money in the long run as IDOT can anticipate and plan for these types of problems.

U.S. GeoSurvey water watch: Illinois GeoSurvey helps out

Myrna Killey, Rick Rice
Kelly Warner, USGS

How does land use affect the groundwater quality in the unconsolidated sediments overlying bedrock? The USGS Water Resources Division (Urbana office) set up a network of 60 observation wells for monitoring the shallow water resources in the Illinois River Basin, as part of their National Water Quality Assessment.

"Shallow," for this project, meant "just below the water table." The USGS field team planned to set well screens at the first water-yielding layer, then regularly sample the water during the year.

What they needed to know, and the State's geologists could tell them, is the nature and properties of each layer of earth material at the monitoring sites.

So the USGS contracted with the Illinois GeoSurvey to drill about 60 holes from 10–60 feet deep. When cores of earth materials were pulled up, they were examined and described on site. Once carefully packed, all cores were sent back to the Geological Samples Library at the GeoSurvey, where they are preserved for further geologic studies of the Illinois River Basin.

What's underground in Illinois? Search our samples "library"

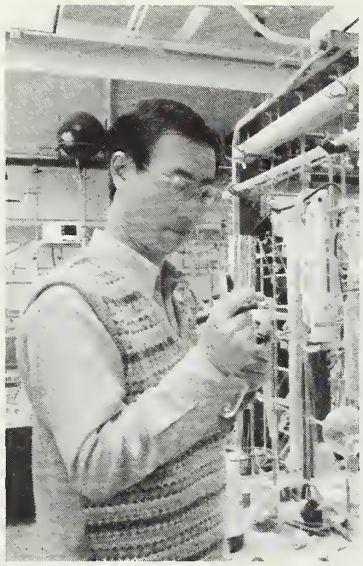
Mike Sargent, Mary Jones
Robert Mumm, Bill Revell

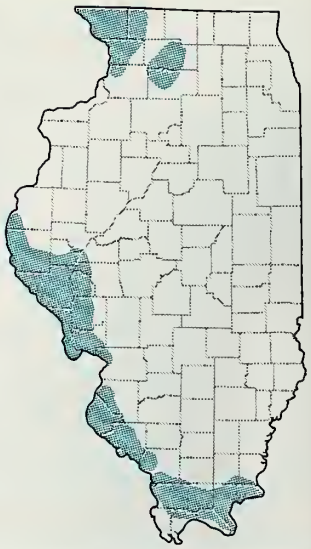
Generations of drillers and geologists have been boring deep into Illinois for water, coal, oil, and minerals—or just to find out what's under their feet.

The cores and cuttings brought up during drilling are a valuable record of the geologic history of Illinois going back as much as 1.6 billion years. Drilling is expensive, and of course, geologists don't want to keep returning to the same sites to drill.

That's why for more than 90 years, the GeoSurvey has been collecting drilling samples for the use of scientists and the public. The collection, now housed in the Geologic Samples Library, contains more than 84,000 well samples. This year, samples from 426 wells were added. The two largest collections are of cylindrical rock cores and of cuttings, the chips of ground-up rock brought up during drilling.

More than 100 people—about half of them from outside the GeoSurvey—visited the samples library this year and examined more than 250 sample sets. Users included oil and coal geologists, quarry operators, minerals prospectors, students doing lab exercises, and of course, research geologists.





Earthquake origins studied with new seismic data collection

John McBride
Dennis Kolata

The GeoSurvey has acquired some of the largest donations of seismic reflection data in its history. Responding to the GeoSurvey's proposal to provide these data for public research, Mobil Oil and several other petroleum companies donated approximately 1,500 miles of seismic reflection profiles for the major oil-producing region of the Illinois Basin in southern and central Illinois.

Because this is exceptionally valuable information, petroleum companies are usually not eager to let it out; but the GeoSurvey convinced them that the data (which cannot be released to a third party) would be useful in studying the role of deep faults in folding of overlying sedimentary strata, the origin of earthquakes, and the underpinnings of the earth's crust beneath the Illinois Basin.

These data have already been useful *[see column, right]* for understanding the region. Acquiring seismic reflection data can cost at least $4,000 per mile in manpower and equipment, which shows how valuable these donations are for Illinois.

Seismic mapping of faults and rock layers in Illinois Basin

John McBride

In the midcontinent United States, large earthquakes seem to occur about every 100 years, but reliable seismic data exist only for the past few decades. Fully understanding earthquake activity here is going to take some time. Similarly, the deep geologic structure underlying Illinois below depths of about 10,000 feet is not well known.

The GeoSurvey's investigation of these issues has been helped immensely by the acquisition of oil company seismic reflection data *[see column, left]*. The data were recently used to map out fault zones in the crust and sediments. One set of data, which passes near the epicenter of the magnitude 5.5 earthquake of 1968, shows a zone that may represent hidden thrust faults reactivated by forces that caused the quake. This is the first time an earthquake-related geologic structure has been identified beneath Illinois.

The data have also been used to begin mapping the overall structure of the deep basement rock. Although this study is in the early stages, GeoSurvey scientists are now beginning to be able to make intelligent guesses as to what it might be.

Unique lab analyses identify sources of landfill contaminants

Jack Liu
Keith Hackley

Using environmental isotopic analyses, chemists in the GeoSurvey's Isotope Geochemistry Laboratory were recently able to provide clear-cut evidence of the source of contaminants appearing in monitoring wells at several municipal waste landfill sites in Illinois.

This novel approach analyzes carbon and hydrogen isotopes of major components in the liquid leachates and gases produced in landfills. The traditional method of tracing leachates and gases is chemical analysis of minor components and trace elements, but these are subject to alteration as they migrate in the ground. The lab, however, analyzes the distinct isotopic signature of landfill leachate and gases. Elevated levels of the hydrogen isotope tritium (partly from landfilled glow-in-the-dark wristwatches) and the isotope carbon-14 (from landfilled paper made from trees that grew following atmospheric testing of nuclear weapons) give the leachate and gases distinct signatures.

These signatures allow the chemists to determine just where contamination detected in the monitoring wells comes from.

Karst country—sinkholes, caves, and disappearing streams

Sam Panno, Pius Weibel
Ivan Krapac

The mystery of where water goes in the sinkhole plain of southwestern Illinois is closer to being solved by new maps from the GeoSurvey. The groundwater basins of four of Illinois' largest caves were mapped from records of a 2-year study on the structure, form, and distribution of karst features.

The maps are a big help to the Monroe–Randolph Bi-County Health Department, Nature Conservancy of Illinois, and Illinois Office of Realty and Environmental Planning. Identifying the boundaries of groundwater basins is a high priority, especially when reviewing proposed sites for subdivisions.

Why more than half the wells in the area are contaminated may also be a matter of record soon. Analyses of groundwater samples from 15 springs, 30 bedrock wells in the sinkhole plain, and about 25 sites in Illinois Caverns revealed bacteria characteristic of human waste.

Tracking the contamination, researchers found that most of the 20 private septic systems they sampled fail to meet state and local regulations. Many discharge directly into sinkholes —and into the local aquifer. That makes septic systems prime suspects in the search for contaminant sources.

State's aquifer map: where's water quality at risk?

Ed Mehnert, Don Keefer
Bill Dey

n 1995, the GeoSurvey pub-ished the map, *Aquifer Sensitiv-ty to Contamination by Pesticide .eaching in Illinois*. The Illinois)epartment of Agriculture IDOA), which funded the map nd a companion report, wanted . map to help in determining vhere the quality of water in hallow aquifers is at risk.

How well does a geologic nap work as a predictor of water uality? To test the map, the eological and Water Surveys re installing (also partly funded y IDOA) a statewide monitor-g-well network to check top-ost aquifers (nearest land sur-ce) for agricultural chemicals.

More than 80 wells are now cated in six distinct geologic ettings across the state. IDOA handling the sample collection nd analyses; the GeoSurvey is naracterizing the geology of ach location; and both Scientific urveys are statistically analyz-g the data.

Pesticides in dug wells can't be traced back to one source

Ed Mehnert, Don Keefer
Bill Dey

When atrazine and nitrates were detected in two large-diameter, dug wells on farms in south-central Illinois, people blamed the contamination on well construction and land-use practices (such as pesticide spills or residues washing into wells when it rains).

The Geological and Water Surveys, supported by the Environmental Protection Trust Fund, set up monitoring wells around two dug wells, then sampled these and the farm wells for 9 months. Sometimes pesticides turned up in the samples; sometimes not.

The dug wells were drawing water from thin sands and fractures in fine-grained, clayey till lying near the surface. But samples from the monitoring wells showed pesticides in the sands lying below the tills.

So far, all the monitoring and dug well samples point to the same conclusion: that the quality of local groundwater varies quite a bit from the surface to about 50 feet deep. The pesticides can't be traced back to one place or one point in time.

The sources are likely to be agricultural use of chemicals.

Groundwater monitored for contamination from hog waste lagoons

Ivan Krapac

The recent influx of large-scale hog operations in Illinois has raised many concerns about the potential for waste lagoons at these sites to contaminate groundwater.

To assess the risk, the GeoSurvey is monitoring two lagoons. Although no evidence has emerged showing any impact on groundwater quality beyond the boundaries of the farms, concentrations of ammonia and chlorides were quite high when compared with background levels in some monitoring wells near the lagoons. These findings show that there is seepage from these unlined lagoons and that there is the potential to impact groundwater.

In finding that these lagoons do leak, the study indicates that current and future regulations requiring impermeable liners in certain geologic settings are appropriate. The study also indicates the need for good management of these sites to protect groundwater.

This study will improve our understanding of the types of contaminants that can leak from waste lagoons and the distance these contaminants can travel.

Planting over slurry ponds solves two coal waste problems

William Roy, Gary Dreher
John Steele

From lab to greenhouse to field test, a new method of reclaiming coal slurry ponds is proving successful.

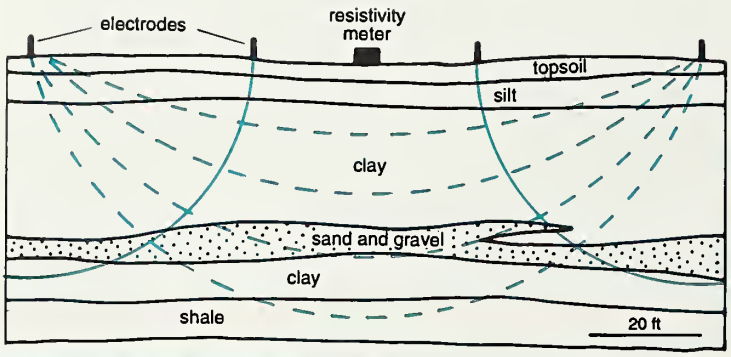
Illinois coal processing plants generate huge piles of wastes. Some wastes, the fine particles washed from coal, are mixed with water and end up as ponds of coal slurry. Another waste is the alkaline ash that results from a new coal burning process.

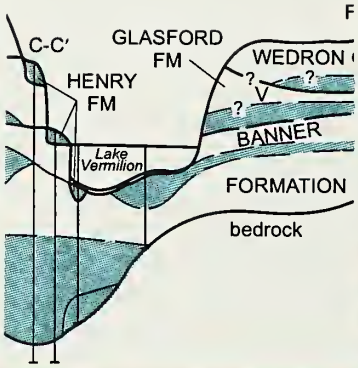
Covering the slurry ponds (which can generate acid runoff) with soil and grass costs the coal industry up to $10,000 per acre.

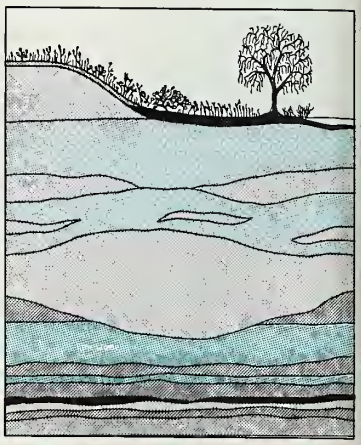
Survey scientists are testing whether combining acidic coal slurry with alkaline ash makes a neutral foundation for vegetation, thus disposing of ash waste and reclaiming slurry ponds.

After 3 years of testing plant germination and different slurry-ash mixtures in the lab and greenhouse, the project was tested last summer in a slurry pond. Even after less than one season of growth, the project reports positive results:

- The slurry-ash combination supports plant growth under field conditions.
- Adding fly ash did not produce new potential contaminants into the slurry pond or result in groundwater contamination.







Homer hits water bonanza—thanks to Illinois GeoSurvey

Tim Young

In 1996, the growing village of Homer in Champaign County was looking for more water. After 3 years and a sizable investment in dry test holes, the village turned to the GeoSurvey, which had helped Homer locate three good wells in the past.

The GeoSurvey's records on groundwater resources revealed 4-year-old reports to village officials recommending exploration north and west of Homer across the Salt Fork River and north of Homer Lake. Broad screening of the area called for geophysics—an electrical earth resistivity survey *[see column, right]*.

To cover about 10 square miles, the geophysics team set up a grid of 150 stations, and at each, took readings to 200 feet deep. After interpreting the EER data, they targeted three locations for drilling.

At the first site, the drill bored through 47 feet of till and hit 100 feet of coarse sand and gravel in a buried preglacial channel, cut even more deeply into bedrock by water from a melting glacier.

The State Water Survey, after a 7-day pump test and months of monitoring three more wells, pronounced the yield 195 gallons of water per minute.

Trouble finding water? GeoSurvey helps with EER surveys

Tim Young
Ross Brower

Last year, more than 40 electrical earth resistivity surveys guided the drilling for water. Here's what you need to know:

- EER, electrical earth resistivity, won't tear up your land. It's a noninvasive method.
- An EER survey can screen a large area, in contrast to spot coverage with costly test drilling.
- Electrical current goes through electrodes (turns on like flipping a light switch) into the ground and through earth materials with different properties. Clay, for example, conducts electricity fairly well; so its resistivity is low.
- Low resistivity values usually indicate fine-grained, compact clays and silts that won't yield much water.
- High resistivity values generally indicate porous, coarse-grained, loose materials such as sand and gravel that could yield generous supplies of water.
- EER shows areas of high resistivity: the higher the resistivity values, the better the chance for finding water-bearing deposits of sand and gravel.
- After interpreting the EER data, the GeoSurvey supplies a report, including potential depth of sand and gravel, and a site map with likely locations for drilling. Sometimes there are none.

Danville, Illinois, where groundwater is in short supply

Dave Larson, John Kempton
Scott Meyer, ISWS

Nitrate levels in Lake Vermilion, the source of Danville's water, periodically shoot up to 10 mg/L (milligrams per liter)—higher than acceptable for drinking water. Could groundwater be used to dilute the nitrate in water drawn from the lake?

The local water company had to first find out how much groundwater was available from sand and gravel deposits under the Danville–Lake Vermilion area.

The Geological and Water Surveys had conducted geophysical surveys, test drilling, and aquifer tests in the area during the late 1970s and 1980s. So the two Surveys were asked to recommend new test drilling sites, and later, to compile and evaluate all the information.

The news was not good:

- Groundwater is in short supply because the sand and gravel aquifers under Danville are not thick and continuous.
- A high-capacity municipal well would probably drop water levels in nearby domestic wells.
- The rate of withdrawing water from these aquifers would likely be greater than the rate of recharge, that is, replenishment by rainwater entering the ground and percolating downward into the aquifer.

GeoSurvey helps Ecosystem Partnerships protect resources

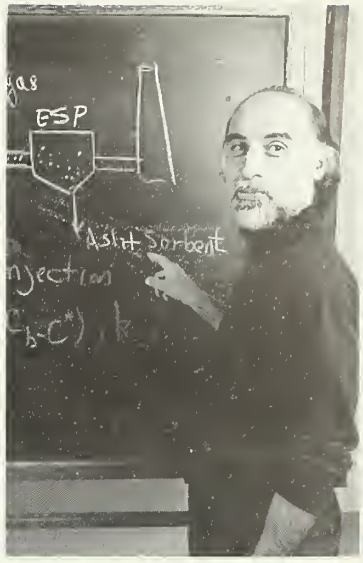
Myrna Killey, Dick Berg
Dan Barnstable

Groundwater, soils, minerals, vegetation, and animal life—GeoSurvey geologists are describing the role geology plays in all aspects of an ecosystem in a series of reports produced by the Illinois Department of Natural Resources (DNR) for local Ecosystem Partnerships.

The partnerships are part of DNR's Ecosystems Program. Composed of local and regional interests—such as conservation, hunting and fishing, and education—the local partnerships are committed to maintaining and enhancing the ecological and economic conditions in their areas.

The assessment reports, written by DNR's Scientific Surveys, will help the local Ecosystem Partnerships manage and improve their ecosystems, habitats, and natural resources.

The GeoSurvey reports describe the geologic features—from bedrock to land cover, groundwater, and geologic hazards—that affect habitat maintenance, distribution and mobility of agricultural chemicals, land cover, mineral extraction, waste disposal, and other human uses of the land.



New look for educational pubs

Geoscience Education and Outreach

After 40 years in print, some of the GeoSurvey's best-selling publications are looking a bit out-of-date. This year they're getting a new look and new names.

The old Educational Series booklets—including the best-selling *Guide for Beginning Fossil Hunters*, *Rocks and Minerals of Illinois*, and *Guide to Pennsylvanian Fossil Plants of Illinois*—are being continued as the GeoScience Education Series.

The first booklet featuring the larger format and two-color printing is *Illinois' Ice Age Legacy*, written by Myrna M. Killey. The extensively illustrated booklet is aimed for the general public, teachers, and armchair geologists. Next in the GeoScience Education Series will be *Groundwater: A Vital Illinois Resource*, by Killey and David R. Larson.

The 25-year-old Geogram series now appears with a fresh design as "Geobits." These one-sheet write-ups requested by teachers, parents, and students answer often-asked questions about geologic subjects.

The first four new Geobits are about glacial erratics, end moraines, geodes, and the Tully Monster, the State Fossil.

Field trippers learn geology first-hand

Wayne Frankie
Russ Jacobson

Last year, more than 1,200 weekend geologists abandoned their softball games, gardening, and barbecues to join GeoSurvey geologists on field trips to three areas in Illinois.

Survey members led students, teachers, cave explorers, rock and fossil collectors, and some who just wanted to get out for a day in the country on field trips to the Mount Carmel area (Wabash County), the Columbia-Waterloo area (Monroe County), and the Buffalo Rock and Matthiessen State Parks area (La Salle County).

Field trippers met in the morning and caravaned by cars and vans to selected sites in each area. At the stops, there were presentations by Survey geologists and experts about the site, minerals or fossils to collect, caves and quarries to explore, time for lunch, varied scenery to enjoy, and opportunities to talk with scientists from the Geological and Natural History Surveys.

Each field tripper received a free illustrated guidebook, which describes the regional geologic history and the sites along the tour.

To find out how to join our next field trip, call 333-ISGS or visit our website: http://www.isgs.uiuc.edu/isgsroot/fieldtrips/fieldtrip97.html

GeoSurvey keeps records on more than 10,000 monuments

Ed Scoggin

10,000 or more geodetic monuments dot the Illinois landscape. They give surveyors and engineers fixed reference points on location and elevation.

But how do the surveyors know where the monuments, or bench marks, are? One call to the GeoSurvey does it.

The GeoSurvey maintains records on all the monuments in the state. Since the 1920s, railroads, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), the U.S. Geological Survey, and some counties have planted monuments for surveying.

These monuments are small metal discs set into the ground or on stable structures like bridge abutments, public buildings, traffic sign posts, or water towers. Stamped on the monument is a brief identification of who planted it, but not its precise longitude and latitude or elevation.

Instead of contacting the various agencies for information about the monuments, surveyors and engineers know the GeoSurvey is the one-stop place to call to get the information—and for free.

During the field months of spring, summer, and fall, the GeoSurvey responds to 30 to 40 requests per month.

GeoSurvey scientists join colleagues in Academe

GeoSurvey scientists are being called back to the classroom, but not because they need more training.

Recognized for their scholarly achievements, they are being asked by their academic colleagues to help train the next generation of geologists.

As academics, Survey geologists teach entire courses, give guest lectures, deliver departmental seminars, advise student research, and serve on thesis committees.

At the University of Illinois campus, home of the GeoSurvey, Chief Shilts, Keros Cartwright, Heinz Damberger, Leon Follmer, Dennis Kolata, and Morris Leighton are adjunct professors in the Geology Department, where Duane Moore, Brandon Curry, and Tim Larson also teach. At nearby Parkland College, Myrna Killey and Robert Vaiden regularly teach geology.

The GeoSurvey's scientists are in demand in other fields too. Massoud Rostam-Abadi and Mark Cal are adjunct professors in Environmental Engineering. William Roy is an associate professor in Natural Resources and Environmental Sciences.

Other active research projects

Analytical Geochemistry

Chemical Characterization of Sediments in Copper Slough, R. Cahill

Distribution of Acetogenic Bacteria in Anaerobic, Carbon-Rich Sediments, J. Risatti, A. Capelli, C. Shiffer

Determination of Germanium in Coal Ash by X-Ray Fluorescence Spectrometry, Y. Zhang

Long-Term Hydraulic Performance of Compacted Soil Liners, I. Krapac

Metal Distributions in DePue and Turner Lake Sediments, R. Cahill

Origin and Regeneration of Nitrates in Mammoth Cave Sediment, I. Krapac

RNA and DNA Protocols for Identification of Methanogenic Microorganisms in Organic-Rich Sediments, J. Risatti, J. Benson, A. Capelli, C. Shiffer

Transport of Agrichemicals in Alluvial Aquifers and Nitrate Attenuation by a Riparian Woodland: Effects of Flood Conditions, J. Risatti, E. Menhert, C. Shiffer, A. Capelli, J. Madsen, O. Richter, M. Walsh, T. Steckler

Coal

Coalbed Methane Studies on Five Cores from the Deep Part of the Basin, H. Damberger, C-L. Liu

Correlation and Coal Resources in the Corinth/Chapel/Womac Coal Beds of Southeastern Illinois, R. Jacobson, R. Peppers, J. Nelson

Development of a Basinwide Database on Major Coal Seams of the Illinois Basin, H. Damberger, C. Treworgy, Indiana, Kentucky, and U.S. Geological Surveys

Dinosaurs of the McNairy Formation and Studies of the K/T Boundary in Illinois and Missouri, R. Jacobson, J. Devera, G. Darrough (St. Louis University), M. Fix (University of Missouri)

Distribution, Correlation, and Coal Beds of the Caseyville and Part of the Tradewater Formations, R. Jacobson, J. Nelson, B. Seyler

Excess Moisture in Illinois Coal and Tax Implications, H. Damberger

Illinois Coal Reserve Assessment and Database Development, C. Treworgy, E. Prussen, M. Justice, C. Chenoweth, M. Bargh, R. Jacobson, H. Damberger, R. Bonskowski (USDOE)

Maintenance of Coal Mine and Resource Data, C. Treworgy, C. Korose, J. McBeth, D. North

Mineralogical and Chemical Composition of Inorganic Matter from Illinois Coal, I. Demir, R. Hughes, J. Lytle, R. Ruch, C-L. Chou

Palynological Zonation of Pre-Desmoinesian Strata in the Forest City Basin and Correlation with the Illinois Basin, R. Peppers, W. Hower (Missouri Geological Survey), D. Smith (Missouri Geological Survey)

Palynology and Correlation of Atokan and Lower Desmoinesian (Pennsylvanian) Strata in the Illinois Basin and Eastern Kansas, R. Peppers, L. Brady (Kansas Geological Survey)

Palynology of the Lost Branch Formation in Kansas, with Implications on the Origin of Pennsylvanian Black Shales in Illinois, R. Peppers

Washability of Air Toxics in Illinois Coal—Gravity-Based Cleaning, I. Demir, R. Ruch, J. Lytle, C. Rohl, L. Khan, J. Steele

Coastal and Wetlands Geology

Preliminary Evaluations for Construction of Artificial Fishing Reefs in Southern Lake Michigan, M. Chrzastowski

Engineering Geology

Central U.S. State Geologists' Mapping of the Midwest for Soil Amplification of Ground Motion in the Event of an Earthquake, W. Shilts, R. Bauer

Computerization of Particle-Size Analysis and Rock Mechanics Test Results, W-J. Su, D. Adomaitis, M. Hart

Earthquake Response Team, R. Bauer, T. Larson, W-J. Su

Geology for Tunneling for Future Accelerators at Fermi National Accelerator Laboratory, D. Gross, R. Bauer

Governor's Task Force on Blasting and Landfills, R. Bauer, K. Cartwright

Inventory of Aerial Photographic Coverage in the Illinois Department of Natural Resources, C. Stohr

Particle-Size Analysis Laboratory, D. Adomaitis

Engineering Geology and Environmental Site Assessment

Assessment of Metals Distribution and Transport in Groundwater Beneath the Diked Sediment Disposal Area, DePue Wildlife Management Area, A. Erdmann, K. Carr, D. Adomaitis, and Illinois State Water Survey

Illinois Department of Transportation Maintenance Facility Assessment Program, IDOT property assessment staff

Environmental Site Assessments

Directory of Illinois Libraries with Historical Resources Commonly Used for Preliminary Environmental Site Assessments, C. Black, J. Ousley, P. Bannon, M. Krick, L. Raymond.

Geospatial Analysis and Modeling

Henry County: Digital Compilation of Geologic Maps, R. Krumm, B. Stiff

Wabash Valley Seismotectonic Map, R. Krumm, J. Hester

Shawnee National Forest: Digital Compilation of Geologic Maps, R. Krumm, B. Stiff

Groundwater Resources and Protection

Environmental Assessment of Coal Waste Disposal in an Underground Mine, E. Mehnert

Groundwater Geology of the Buried Mahomet Valley Aquifer System, Focusing on De Witt and Piatt Counties, B. Herzog, D. Larson, T. Larson, S. Sargent, M. Mushrush

Groundwater Geology of De Kalb County, Focusing on Aquifers in Buried Valleys, T. Larson, R. Vaiden, E. Smith.

Preferential Flow in Tile Effluent, D. Keefer, W. Dey

Statistical Evaluation of Data from Sites of Multiple Spills of Agricultural Chemicals , D. Keefer, M. Barnhardt

Hydrogeology Laboratory

Fate and Transport of Chemicals in Fractured Platteville and Galena Aquifer in Boone and Winnebago Counties, M. Heidari, D. Kolata

Field Guide to Illinois Caverns, S. Panno

Groundwater Flow Paths and Contamination of Municipal Landfill in a Karst Terrain, S. Panno

Mechanism of Transport of Nutrients in Alluvial Aquifers during Normal and Flood Conditions: Phases II and III, M. Heidari

Role of Flooding and Land-Use Practices on Erosion Rates and Agrichemical Loading in the Southwestern Illinois Sinkhole Plain, S. Panno

Industrial Minerals and Economics

Depositional History and Economic Significance of a Middle Mississippian Crinoidal-Bryozoan Carbonate (Ullin and Fort Payne Formations) in the Illinois Basin, Z. Lasemi

Diagenesis of the Illinois Basin, R. Hughes, D. Moore

Directory of Mineral Producers in Illinois, V. Ipe, J. Masters

Geoarchaeological Studies, R. Hughes

Geologic Mapping in Brownfield, Paducah NE, Southern Illinois, J. Masters, W.J. Nelson

Geologic Mapping of Metropolis and Joppa 7.5-Minute Quadrangles, J. Masters, J. Nelson

Illinois Mineral Industry Report for 1994-1996, V. Ipe

Industrial Minerals Service and Outreach, R. Hughes, Z. Lasemi, D. Mikulic, J. Masters, S. Bhagwat, D. Moore, P. DeMaris, V. Ipe

Mercury Capture Across FGD Systems, S. Bhagwat, V. Ipe

Middle Devonian Carbonates in Central Illinois: Depositional History and Economic Significance, Z. Lasemi

Mineral Industry Map of Illinois, J. Masters, L. Smith

Mineralogical and Chemical Composition of Inorganic Matter of Coals, R. Hughes, P. DeMaris

Mollusks and Other Marine Macrofossils from the Paleocene-Age Clayton Formation of Southernmost Illinois, J. Masters

Nodular Cheilostome Bryozoans from the Basal Paleocene of Southernmost Illinois, J. Masters

Predicting Limestone Quality and Reserves in the Mississippian Salem Limestone, Western Illinois, Z. Lasemi

Review of 1995 Mineral Exploration Activities in Illinois, J. Masters, H. Damberger

Sequence Stratigraphy and Economic Significance of Mississippian Carbonates in Western Illinois, Z. Lasemi

Utilization of Fly Ash, R. Hughes, P. DeMaris

Internet

Maintain and Enhance Survey Web Pages, S. Denhart

Isotope Geochemistry

Development of Nitrogen Isotope Analysis Techniques for Dissolved Nitrogen Species in Water, H. Hwang

Environmental Isotope Characteristics of Landfill Leachates and Gases, K. Hackley, C-L. Chou, D. Coleman

Geochemistry of Paleozoic Carbonate Rocks in Illinois, C-L. Chou, Z. Lasemi, J. Masters

Geologic Factors Affecting the Abundance Distribution, and Speciation of Sulfur in Coals, C-L. Chou

Isotopic Analysis for Water and Carbonate Samples, H. Hwang, S. Greenberg, C. Gerdon

Paleoclimate Oscillation in Mississippi River Valley, H. Wang, L. Follmer, C-L. Liu

Radiocarbon Dating of Old Soil Organic Matter, H. Wang, C-L. Liu, and S. Shiffer.

Radiocarbon Dating Service Lab, C-L. Liu, H. Wang, S. Shiffer

Minerals Engineering

Acquisition and Characterization of Coal-Fired Scrubber Byproducts, L. Khan, J. Lytle

Activated Char for Combined SO_2/NO_x Removal, A. Lizzio, S. Desai, G. Murphy, G. Donnals, M. Cal, J. Lytle, NOXSO Corp.

Carbon-Based Adsorbents from Waste Tire-Paint Sludge Mix for Control of Gasoline Emissions from Automobiles, M. Rostam-Abadi, J. DeBarr, Ford Motor Company, and University of Illinois

Carbon Molecular Sieves for Oxygen Separation from Air, M. Cal, K. Slota, and UIUC

Effects of the Chlorine in Coal on Boiler Corrosion, M. Chou, J. Lytle, R. Ruch, K. Hackley, J. Bruinius, Babcock and Wilcox, Sandia National Labs

Instrumental Method for Directly Determining Organic Sulfur in Coal, C. Chaven, J. Lytle, J. DeBarr, K. Henry, C. Rohl

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For more information

ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody Drive
Champaign, Illinois 61820
217/333-ISGS

William W. Shilts, Chief
217/333-5111
David L. Gross, Assistant Chief
217/333-0150
Beverly L. Herzog, Head, Blue Group
217/244-2788
E. Donald McKay, Head, Orange Group
217/333-0044
Jonathan H. Goodwin, Head,
Communications and Geoscience
Information Group
217/333-5855
Gerald E. Glogowski, Head, Administrative and General Services Group
217/244-2403
Richard C. Berg, Interim Director,
Geologic Mapping Program
217/244-2776

Analytical Geochemistry
Gary B. Dreher
217/244-2527

Coal
Heinz H. Damberger
217/333-5115

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217/333-3567

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Wayne T. Frankie
217/244-2427

**Geospatial Analysis and Modeling,
and Geological Records**
Robert J. Krumm
217/333-4085
217/333-5109

Groundwater Resources and Protection
Beverly L. Herzog
217/244-2788

Human Resources
Linda M. Cunningham
217/244-2402

Hydrogeology Research Laboratory
Keros Cartwright
217/333-5113

Industrial Minerals and Economics
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217/244-0080

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217/244-8389

Oil and Gas
Beverly Seyler
217/244-2389

Quaternary Geology
Ardith K. Hansel
217/244-5852

Sedimentary and Crustal Processes
Dennis R. Kolata
217/244-2189